COHERENT®

Laser Measurement and Control

2010/2011 Catalog

Power and Energy Measurement

Custom Power and Energy Solutions

Beam Diagnostics

Superior Reliability & Performance

Coherent Operational Excellence

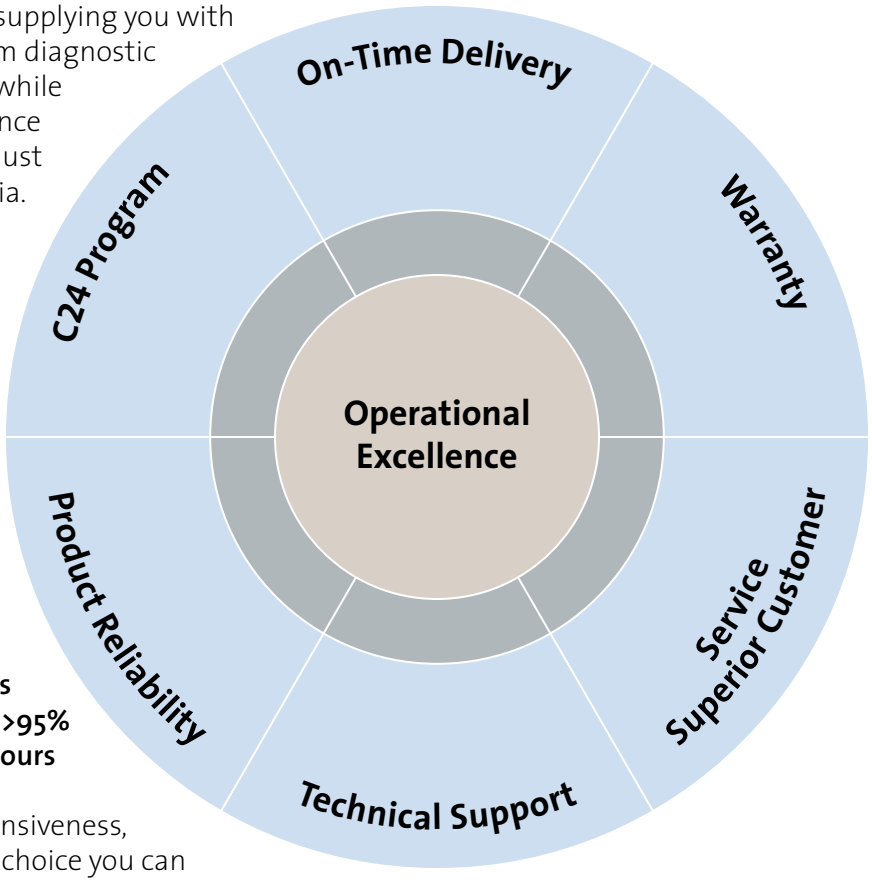
Operational Experience You Can Count On

For over 40 years, Coherent has been supplying you with the best laser measurement and beam diagnostic equipment available. We realize that while technical specifications greatly influence your purchasing decisions, you also must consider many other important criteria.

In a recent customer survey we found that Product Reliability, Speed of Responsiveness, and Technical Support are the three top criteria when choosing a laser test and measurement supplier. That's why we place as much emphasis on Operational Excellence as we do on technical superiority. Operational Excellence means:

- **Overall product warranty rate <1%**
- **Calibration turnaround time <5 days**
- **On-time delivery for all new orders >95%**
- **Shipment of C24 orders within 24 hours**

For Product Reliability, Speed of Responsiveness, and Technical Support, make the safe choice you can always count on – Coherent.



The Coherent Laser Measurement Newsletter

To keep informed about our latest laser measurement and beam diagnostics product releases, product upgrades, and special promotions, please sign up for our electronic newsletter at: www.Coherent.com/LMC.

We Want You to Know What's New

New Mailing Address

Coherent Inc., Portland
27650 SW 95th Avenue
Wilsonville, OR 97070

New Phone Number

Phone:
(800) 343-4912 or
(408) 764-4042

New Fax Number

Fax:
(503) 454-5727

Online:
www.Coherent.com

Laser Measurement and Control

Table of Contents

New Products

New Products	4-5

Power and Energy Meters

Power and Energy Measurement Solutions	6-7
Power and Energy Meter Quick Reference Guide	8
Compatibility Chart for Our Most Popular Meters and Sensors	9
LabMax Meters	10-12
FieldMaxII Meters	13-14
FieldMate	15
EPM2000	16

Power Sensors

Introduction and Selection Charts	18
Long-Pulse Energy Measurement with a Thermopile	19
PowerMax-USB/RS Sensors Product Overview	20-22
PowerMax-USB/RS Sensors	23-30
PowerMax-USB/RS Sensor Accessories	31
Power Sensor Summary Specifications (standard DB25 LM and PM models)	32-33
LM Model Beam Position Sensing Thermopile Sensors (10 mW to 5 kW)	34-37
High-Sensitivity Optical Power Sensors (10 nW to 50 mW)	38
PM Model Thermopile Sensors (100 µW to 5 kW)	39-44
PM Model Large-Area High-Power Water-Cooled Thermopile Sensors (100W to 5 kW)	45
PM Model High-Peak-Power Thermopile Sensors (10 mW to 30W)	46
PM Model Thermopile Sensors with UV Coating (10 mW to 1 kW)	47-49
Power Sensor Accessories	50-51

Energy Sensors

EnergyMax Introduction and Selection Charts	52-56
Energy Sensor Summary Specifications	57
EnergyMax Sensors	58-63
EnergyMax Heat Sinks	64
EnergyMax Accessories	65

Laser Measurement and Control

Table of Contents

Energy Sensors (cont.)

Measuring Energy with an Oscilloscope	66
J100 Energy Sensor	67

Custom and OEM

Custom and OEM Products Introduction	68
OEM Thermopiles (10 mW to 1 kW)	69-70
OEM Thermopile Detailed Drawings	71

Beam Diagnostics

Introduction to Laser Beam Diagnostics	72-73

Beam Diagnostic Cameras

LaserCam-HR	74
LaserCam-HR-UV	74
LaserCam-HR-InGaAs	75

BeamView-USB Analyzer Software

BeamView-USB	76-81

Beam Diagnostic Accessories

Laser Grade Attenuation Optics for Cameras	82
Attenuation Optics for Cameras	83
Extreme-UV Beam Intensity Profile Optics	84

BeamMaster

Knife-Edge Based Beam Profilers	85-87

ModeMaster PC

M^2 Beam Propagation Analyzer	88-93

WaveMaster

Laser Wavelength Meter	94-95

Laser Measurement and Control

Table of Contents

Calibration, Warranty and Service 96-97

Measurement Products for Use with Coherent Lasers 98-100

Model Name Index 101-102

Doing Business with Coherent 103

How to Contact Us 104

Visit the Coherent Website Inside Back Cover

New Products

New to the Catalog

PowerMax-USB/RS Sensors

PowerMax-USB Sensors

Features

- PowerMax-USB provides direct USB 2.0 connection to PC. Power provided via USB connection.
- PowerMax-RS provides RS-232 connectivity. Power input provided via +5 VDC input.
- Instrumentation platform is compatible with thermopiles and optical sensors
- Displays beam position with position-sensing quadrant thermopiles (with LM-model sensors like LM-10)
- Complete meter electronics inside connector
- Power range µW to kW

PowerMax PC Software

Features

- Trending Statistics (mean, minimum, maximum, and standard deviation) and log batch to file
- Tuning Display beam position on position-sensing thermopiles and log results to file Histogram
- Operate multiple devices simultaneously
- Perform synchronized ratiometery (A/B analysis)
- Trend and log results to file.

PowerMax PC Software

New Products

New to the Catalog

J-Quantum EnergyMax Sensors

J-10SI-LE

Features

- Pulse enegy measurement down to 8 pJ (within line; model dependent)
- Average power measurement of pulsed sources from nW to mW level signal-to-noise characteristics
- Measures single pulses to 10,000 Hz
- Accurate spectral compensation
  - 325 nm to 900 nm for Silicon
  - 800 nm to 1700 nm for Germanium
- Robust and reliable construction

J-50MB-IR EnergyMax Sensor

Features

- Very high energy and peak power handling capabilities
- Operate at Nd: YAG fundamental and harmonics, and throughout the IR
- Enable pulse energy measurements from 1 mJ to 3J
- Spectral compensation characteristics built into each unit
- Onboard sensors provide automatic temperature compensation
- No need to either change diffusers during use or perform your own spectral calibrations
- Ideal for medical applications

J-50MB-IR and J-25MB-IR

Power and Energy Measurement Solutions

Sensor Technologies

Coherent offers three different sensor technologies (thermopile, semiconductor/optical, and pyroelectric) that address a broad range of measurement parameters and laser characteristics.

Thermopile

PM Model Thermopiles

LM Model Thermopiles

Thermopile sensors are a great all-purpose technology suitable for many lasers. They are used for measuring CW laser power, average power in pulsed lasers, and are often used to integrate the energy of long pulses.

Thermopile sensors absorb incident laser radiation and convert it into heat. This heat ultimately flows to a heat sink that is held at ambient temperature by either convection-cooling or water-cooling. The temperature difference between the absorber and the heat sink is converted into an electrical signal by a thermocouple junction.

Thermopiles operate across a wide range of input powers, and unlike a semiconductor sensor they will not saturate. The spectral range is dependent upon the coating applied to absorb the laser energy. The coating used on many thermopiles is broadband in nature and is relatively flat from the ultraviolet through the infrared. These sensors have natural response times on the order of several seconds for a low power sensor and up to one minute for a kilowatt sensor. When combined with a Coherent meter a speed-up algorithm provides a much faster response – on the order of seconds for most sensors.

Coherent has two lines of thermopile sensors. The "LM Model" line utilizes a unique thermopile disk in which the thermocouples are split into four quadrants, allowing the sensors to provide beam position information in addition to power measurement. LM Model sensors can be found on pages 34 to 37. The "PM Model" line incorporates traditional thermopile disks that provide power measurement, found on pages 39 to 49.

Quad Positioning Enabled

Semiconductor/Optical

Model OP-2/LM-2

Semiconductor sensors convert incident photons into current that can be measured by our instruments. The photodiodes used in these types of sensors offer high sensitivity and low noise, enabling them to detect very low light levels. They saturate above approximately 1W/cm², so attenuating filters must be used when operating above the milliwatt level.

Photodiodes also have a fast response time, so they are convenient for tuning and peaking lasers. The spectral range is more limited than our other sensor technologies. These devices are also referred to as optical sensors. Semiconductor/optical sensors are limited to measuring CW laser power.

Power and Energy Measurement Solutions

Sensor Technologies

Pyroelectric

EnergyMax - Laser Energy Sensors

Coherent energy sensors use a pyroelectric element to measure the energy in a laser pulse. It does this by producing a large electrical charge for a small change in temperature. The active sensor circuit takes the current from the sensor element and converts it to a voltage that can be measured by a peak detector circuit or a Coherent meter. Pyroelectrics can only be used with pulsed lasers.

Pyroelectric sensors are ideal for measuring the output of pulsed lasers. These devices can be used at repetition rates to 10 kHz and beyond, and can be used to measure laser pulses beyond a Joule.

Sensor Technology Measurement Range

The following information can help determine which sensor technology to choose based upon the type of laser used and the type of measurement needed.

Laser Type	Measurement Needed	Power Range	Wavelength Range	Sensor Type
CW Laser	Average Power	10 nW to 50 mW 100 µW to >5 kW	250 nm to 1800 nm 0.19 µm to 11 µm	Optical Thermopile
Pulsed Laser	Average Power	100 µW to >5 kW	0.19 µm to 11 µm	Thermopile
Pulsed Laser	Energy Per Pulse	100 nJ to >10J	0.19 µm to 11 µm	Pyroelectric
Long Pulse Laser (>1 ms)	Single Pulse Integrated Energy	1 mJ to >300J	0.19 µm to 11 µm	Thermopile

The spectral range of these sensor technologies and absorbing coatings are shown in the table below. After identifying a sensor type and coating, the detailed specifications in this catalog (see pages 32 through 67) can be used to select a specific sensor model for your application.

	Model	Wavelength (nm)	Wavelength (nm) 100 1000 10,000
Thermal Sensors	PowerMax - UV Coating	150 to 1000	
	PowerMax - Broadband Coating	190 to 11,000	
	Volume Absorber	250 to 3000	
Semiconductor Sensors	UV	200 to 400	
	VIS	400 to 1064	
	IR	800 to 1800	
Energy Sensors	MaxBlack Coating	190 nm 12,000	
	MaxUV Coating	190 to 2100	
	Diffuse Metallic Coating	190 to 2100	

After selecting a sensor model, the final step is to identify a meter to measure, display and analyze the sensor output. The information on the next page summarizes the capabilities and features of our meters and lists their compatibility with different sensors. Visit www.Coherent.com/LMC and use our Product Finder to assist you in making your sensor and meter selections.

Power and Energy Meter Quick Reference Guide

Meter Features Summary Table

	FieldMate	FieldMaxII -TOP	FieldMaxII -TO	FieldMaxII -P	LabMax -TOP	LabMax -TO	EPM2000	LaserCheck
Page Reference	15	13	13	13	10	10	16	17
Measurement Modes								
CW Power	•	•	•		•	•	•	•
Avg. Power of Pulsed Lasers	•	•	•		•	•	•	
Long-Pulse Joules		•			•	•	•	
Pulse Energy		•		•	•		•	
Max. Rep. Rate (Hz)		300		300	10,000[1]		1000	
Display Types								
Digital Readout	•	•	•	•	•	•	•	•
Analog Needle Tuning	•							
Graphical Tuning		•	•	•	•	•		
Strip Chart/Trending					•	•		
Measurement Analysis Supported								
Beam Position					•	•		
Statistics		•	•	•	•	•	•	
Display Smoothing		•	•	•	•	•	•	
2-Channel/Ratiometric							•	
Correction Factors Supported								
Wavelength Correction	•	•	•	•	•	•	•	•
Attenuation Factor		•	•	•	•	•	•	
PC Interfaces								
USB		•	•	•	•	•		
RS-232					•	•	•	
GPIB					•[2]		•	
Analog Output	•	•	•	•	•	•	•	
Electrical Power Options								
Battery (rechargeable)		•	•	•	•	•		
Battery (non-rechargeable)	•							•
AC Powered	•	•	•	•	•	•	•	

Meter and Sensor Compatibility Table

Power Sensors								
PM Model	•	•	•		•	•	•	
PS Model	•	•	•		•	•	•	
OP-2 Model	•	•	•		•	•		
LM Model and Beamfinder	•[3]	•[3]	•[3]		•	•	•[3]	
LM-2 Model	•[3]	•[3]	•[3]		•	•		
Energy Sensors								
EnergyMax		•[4]		•[4]	•		•	

[1] 10,000 Hz sampled; 1000 Hz every pulse.
[2] LabMax-TOP w/GPIB model only.
[3] Compatible when used with Thermal SmartSensor Adapter #1056827.
[4] Our J-50MT-10KHz, J-25MT-10KHz, and J-10MT-10KHz EnergyMax Sensors are not compatible with FieldMaxII-TOP meters. For legacy sensor models not listed, please contact Coherent or your local representative for assistance.

Power and Energy Measurement Overview

Compatibility Chart for Our Most Popular Meters and Sensors

POWER

Meters

FieldMate

FieldMaxII

LabMax

Sensors

PM & PS Model Thermopile Sensors/OP-2 Model Optical Sensors

Thermal SmartSensor Adapter

LM Model Thermopile Sensors/ LM-2 Model Optical Sensors

- Power meters compatible with PM & PS Model Thermopile Sensors
- Power meter compatible with LM Model Thermopile Sensors
- Power meters need the Thermal SmartSensor Adapter to use LM Model Thermopile Sensors

ENERGY

Meters

FieldMaxII-TOP and -P

LabMaxII-TOP

Sensors

EnergyMax Pyroelectric Energy Sensors

LabMax Meters

Laser Power and Energy Meters

LabMax-TOP Power and Energy Meter

Features

- Measure power and energy
- Ergonomic design enhances user experience
- Directly compatible with PM Model and LM Model thermopiles
- Display beam position with LM Model thermopiles
- Log data to internal memory, directly onto USB flash drive, or to PC
- USB, RS-232, and GPIB PC interfaces
- Software:
  - LabMax PC applications software
  - LabVIEW instrument driver and ActiveX control

Models

- LabMax-TOP is compatible with thermopile, optical and pyroelectric (power & energy)
- LabMax-TOP w/GPIB adds IEEE-488 GPIB PC interface (cable included)
- LabMax-TO is compatible with thermopile and optical (power and long-pulse Joules)

LabMax is a versatile meter suitable for anyone who needs to analyze laser output. It analyzes and monitors laser output via onboard data logging. It also supports logging data directly to a USB flash drive, provides enhanced data analysis and statistics, as well as a form factor that allows flexible positioning and viewing angles so it can be used in areas with limited bench space. These meters provide direct compatibility with LM Model and PM Model sensors with no need for adapters.

Sensor Compatibility

LabMax displays beam position for quick and accurate setup, and is directly compatible with most Coherent thermal, pyroelectric and semiconductor sensors. These sensors offer wavelength coverage from 190 nm to 12 µm, measure from nW to kW, from nJ to J, and from single shot to 10 kHz.

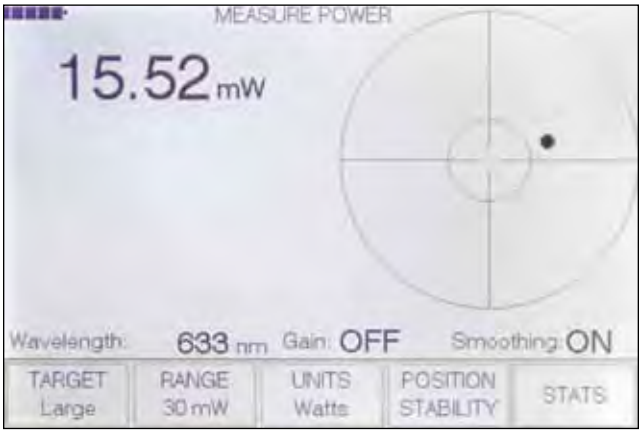
Beam Positioning

The position of the laser beam on the sensor can be displayed by LabMax when using an LM Model thermopile sensor. This makes it easier to align the laser beam during setup, especially for infrared laser beams. There is also a trending feature to monitor the position of the beam over time, and the position data can be logged to a file. Beam position sensors are on pages 34 to 37.

LM-45 HTD sensor with beam position

Data Logging

Data logging of unlimited size can be performed directly to a USB flash drive, and additionally over 400,000 points can be retained onboard the meter itself in flash memory. The meter has a file management system that allows naming and renaming files, auto increments file names for repetitive logging events, folder creation and renaming, and transferring files and folders from the meter storage to a USB flash drive. Data can also be logged to a file with the LabMax PC applications software.



LabMax beam position display

LabMax Meters

Laser Power and Energy Meters

Ergonomic Design

LabMax features a large, backlit graphical display with an ergonomic interface with easily accessible buttons for all features and modes. The Measure, Tune, and Trend modes are directly accessible via front panel buttons.

Front panel buttons

Flexible Positioning

The LabMax display and meter can be positioned at many different angles within the limited bench space typically available in a laser lab, while still making the display easy to view.

Additional Inputs/Outputs

In addition to PC interfacing, LabMax also includes an analog output with user-selectable voltages of 0 to 1V, 2V, or 4V. Pyroelectric triggering can be achieved with an external trigger input or an internal trigger that is user-adjustable from 2% to 20% percent of full-scale range.

Measurement Analysis

LabMax meters contain several advanced analysis capabilities, including:

Onboard statistics – mean, minimum, maximum, standard deviation, range, three stability parameters, as well as missed pulses. Users can also select which statistical parameters to display, up to six at a time.

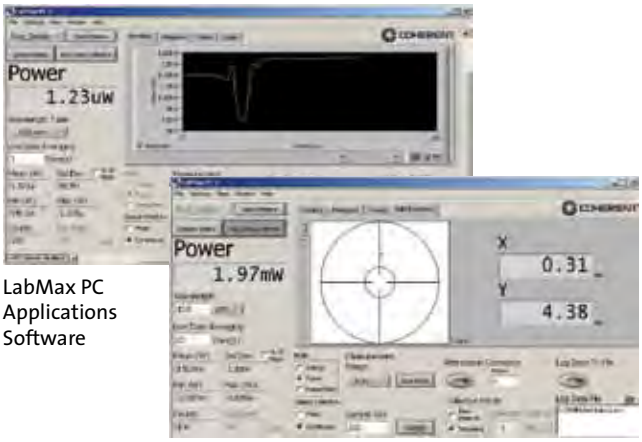
Trend charting – trend chart with statistical display and the ability to log data to a file.

Digital tuning indicators – horizontal bar and trend chart formats with peak indicators.

LabMax Tune Chart

PC Interfacing and Applications Software

Data can also be analyzed directly on a PC through USB, RS-232, or GPIB connections, or by logging data to a USB flash drive attached directly to the meter. Installable applications software and LabVIEW drivers are provided to support PC interfacing.



LabMax PC Applications Software

LabMax Meters

Laser Power and Energy Meters

Device Specifications

Model	LabMax-TOP w/GPIB	LabMax-TOP	LabMax-TO
Measurement Resolution	0.1 % of full-scale		
Displayable Resolution	3 or 4 digits pyroelectric; 3, 4, or 5 digits thermopile and optical (user-selectable)		3, 4, or 5 digits (user-selectable)
Measurement Range	Sensor dependent (reference sensor specifications)		
Accuracy			
Digital Meter	±1.0% ±2LSD		
System	Meter accuracy + sensor accuracy		
Analog Output (%)	±1.0		
Uncertainty (%)	±1.0		
Power Sampling Rate (Hz)	10		
Maximum Repetition Rate (Hz)	10,000 sampling (1000 Hz every pulse)		
Minimum Positional Resolution (mm)	0.1		
Display	112 x 78 mm backlight graphic LCD, 480 x 320 pixels. Adjustable contrast and viewing angle		
Measurement Analysis	Min., max., mean, range, std. dev., dose, stability; trending, tuning, beam position		
Computer Interface	GPIB, USB and RS-232	USB and RS-232	
Pulse Triggering	Internal and external (selectable)		–
Analog Output (VDC)	0 to 1, 2, or 4 VDC (selectable)		
Analog Output Update Rate	Up to 1000 Hz for pyroelectric; 10 Hz for thermopile and optical		10 Hz
Temperature			
Operating Range	5 to 40°C (41 to 104°F)		
Storage Range	-20 to 70°C (-68 to 158°F)		
Instrument Power	90 to 260 VAC, 50/60 Hz		
Instrument Batteries	4400 mAH Rechargeable Li-ion Pack		
Compliance	CE, RoHS, WEEE		
Dimensions (H x W x D)	152 x 229 x 53 mm (6.0 x 9.0 x 2.1 in.)		
Weight	1.25 kg (2.8 lbs.)		
Front Panel			
PWR	Turn meter on and off		
ZERO	Reset ambient offset for thermal and optical sensors		
MEASURE	Main measure mode including statistics		
TUNE	View tuning features		
TREND	Display measured values over a period of time and log data to file		
SETUP	Setup meter parameters		
HELP	Onboard context sensitive help - available from any screen		
BACKLIGHT	Toggle backlight on and off		
KNOB	Turn knob to change settings; press the knob to save settings		
Left Side Panel	USB flash drive port USB PC interface port RS-232 PC interface port DB25 sensor port Power jack		
Rear Panel	Analog output		
	External trigger input		–
	GPIB PC interface port	–	
Part Number*	1104620	1104622	1104619

* Meter supplied with 4400 mAH Li-ion battery, AC power adapter, power cord, 1.8-meter USB cable, RS-232 adapter, USB flash drive, RCA-to-BNC adapters, user manual, software and driver CD, soft carrying case, and certificate of calibration. LabMax-TOP w/GPIB also includes a GPIB cable.

FieldMaxII Meters

Laser Power and Energy Meters

FieldMaxII-TOP Power and Energy Meter

FieldMaxII-TO Power Meter

Features

- Measure energy of pulsed lasers up to 300 pps
- Large, backlight LCD display
- Compatible with thermopile, optical, and pyroelectric sensors
- Simulated analog-like movement for laser tuning
- USB interface with FieldMaxII PC applications software, LabVIEW instrument driver and ActiveX control
- Area function for density measurements (J/cm² or W/cm²)

Models

- FieldMaxII-TOP is compatible with thermopile, optical and pyroelectric sensors (power & energy)
- FieldMaxII-TO is compatible with thermopile and optical (power only)
- FieldMaxII-P is compatible with pyroelectric (energy only)

FieldMaxII is an affordable, versatile, easy-to-use digital power and energy meter platform designed for a variety of applications ranging from field service to production test applications.

FieldMaxII features a large, easy-to-read backlit LCD and an intuitive user interface offering button-driven control for simple operation. The meter supports onboard analysis of mean, min., max., and standard deviation statistics. It can measure power from nW to kW, and pulse energy from nJ to J at up to 300 pps. In addition, long-pulse Joules energy measurements can be made on the FieldMaxII-TOP model when using thermopiles.

The meter includes a USB PC interface as well as an analog output. The FieldMaxII PC applications software supports trend charting, tuning, statistics, and logging data to a file. A LabVIEW instrument driver with ActiveX control is provided to support custom software developments.

FieldMaxII PC Application

Features

- USB PC Interface
- FieldMaxII PC is completely open-source so that you can use it to help develop your own customized applications
- Multiple meters can be run on a single PC – useful for final test and burn-in applications
- Meters can be operated remotely via host interface and included drivers
- Software features:
  - Measure, Tune, Trend displays
  - Statistics
- LabVIEW instrument driver and ActiveX DLL server included

FieldMaxII Meters

Laser Power and Energy Meters

Device Specifications

Model	FieldMaxII-TOP	FieldMaxII-TO	FieldMaxII-P
Function	Power and energy	Power	Energy
Measurement Resolution	0.1% of full-scale		
Measurement Range	Sensor dependent - reference sensor specifications		
Accuracy			
Digital Meter	±1.0% ±2LSD		
System	Meter accuracy + sensor accuracy		
Analog Output (%)	±1.0		
Uncertainty (%)	±1.0		
Power Sampling Rate (Hz)	10	10	–
Maximum Pulse Rep. Rate (Hz)	300	–	300
Display	58 x 73 mm , fixed-segment LCD with backlight		
Digital Tuning Indicator	100 msec time constant		
Statistics	Mean, max., min., standard deviation		
PC Interface	USB 1.1		
Analog Output	0 to 1, 2, or 5 VDC (selectable)		
Internal Trigger	2 to 20% of full-scale, selectable	–	2% to 20% of full-scale, selectable
Temperature			
Operating Range	5 to 40°C (41 to 104°F)		
Storage Range	-20 to 70°C (-68 to 158°F)		
Instrument Power	100 to 240 VAC, 50/60 Hz		
Instrument Batteries	Rechargeable NiMH battery pack		
Compliance	CE, RoHS, WEEE		
Dimensions (H x W x D)	200 x 100 x 40 mm, (7.87 x 3.94 x 1.57 in.)		
Weight	1.0 kg (2.2 lbs.)		
Front Panel			
PWR	Toggle power switch and backlight		
HZ	Display rep. rate	–	Display rep. rate
J/W	Select Joules or Watts mode	–	–
ZERO	Reset ambient offset for thermal and optical sensors		Zero stats
AUTO	Engage auto-ranging with power sensors		–
STAT	Display statistics: mean, max., min., standard deviation		
AVG	Engage display averaging		
λ	Enter wavelength and engage wavelength compensation		
ATTEN	Enter attenuation factor and engage attenuation		
AREA	J/cm² (fluence) W/cm² (power density)	W/cm² (power density)	J/cm² (fluence)
HOLD	–	Holds displayed values on screen	–
TRIG	Select trigger level with energy sensors	–	Select trigger level with energy sensors
SETUP / LOCAL	Set and enter button/Takes local control of meter back from PC		
ARROW KEYS	Manually control range; Select Stats parameter; Select and change numerical values		
Left Side Panels	Power jack		
	USB PC interface port		
	Analog output		
Right Side Panels	DB25 sensor port		
Part Number*	1098580	1098579	1098581

* Meter supplied with NiMH rechargeable battery pack, power cord, AC adapter, USB cable (1.8m), RCA-to-BNC analog output adapter, user manual, installation CD with FieldMaxII PC and drivers, soft carrying case, and certificate of calibration.

FieldMate

Laser Power Meter

FieldMate Power Meter

Features

- **Analog needle for tuning**
- **Large digital LCD display**
- **Compatible with thermopile and optical sensors**
- **Wavelength compensation**
- **Analog output**
- **Compact and portable**
- **AC and battery power**
- **Auto ranging**

FieldMate combines a digital display and analog meter with sophisticated digital processing to enable rapid, sensitive laser adjustment. This meter also offers an economical way of measuring laser power when advanced data analysis is not necessary.

Device Specifications

Model	FieldMate
Power Resolution	0.1% of full-scale for all ranges in the 10s scale 0.3% of full-scale for all ranges in the 3s scale
Measurement Range	Sensor dependent (reference sensor specifications)
Accuracy	
Digital Meter	±1.0% ±2LSD
System	Meter accuracy + sensor accuracy
Analog Meter (%)	±3.0
Analog Output (%)	±1.0
Uncertainty (%)	±1.0
Power Sampling Rate	20 Hz (thermopile and optical)
Display	26 x 89 mm, custom fixed-segment LCD
Analog Needle	
Scale	0 to 10 (100 divisions), 0 to 3 (60 divisions)
Response	80 ms time constant
Analog Output	
Voltage	0 to 2 VDC
Update Rate	20 times/sec.
Temperature	
Operating Range	5 to 40°C (41 to 104°F)
Storage Range	-20 to 70°C (-68 to 158°F)
Instrument Power	100 to 240 VAC, 50/60 Hz
Instrument Batteries	Two 9V alkaline batteries
Compliance	CE, RoHS, WEEE
Dimensions (H x W x D)	193 x 117 x 46 mm, (7.6 x 4.6 x 1.8 in.)
Weight	0.8 kg (1.8 lbs.)
Front Panel	
PWR	Toggle power
ZERO	Ambient offset
AUTO	Engage auto-ranging
λ	Enter wavelength compensation
ARROW KEYS	Manually control range; select and change numerical values
Left Side Panel	Power jack Analog output DB-25 sensor port
Part Number*	1098297

* Meter supplied with two alkaline 9V batteries, power cord, AC power adapter, RCA-to-BNC analog output adapter, user manual, and certificate of calibration.

EPM2000

Dual-Channel Power and Energy Meter

Features

- Measures power and energy
- Repetition rate to 1000 pps
- Dual-channel with ratio measurement
- External trigger input
- RS-232 and GPIB computer interfaces
- Analog output
- LabVIEW driver

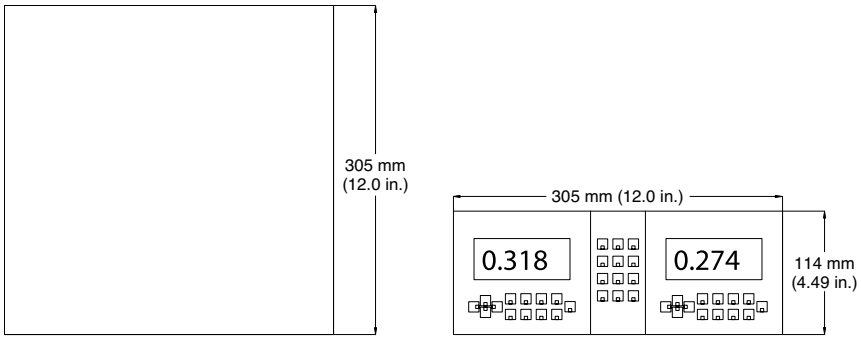
The EPM2000 meter is a versatile, high-performance dual-channel instrument. Each of the EPM2000's channels can be configured as an energy meter or a power meter, regardless of the other channel's setting. Each channel has an independent trigger circuit, but it can also be slaved to the other channel for applications where timing is critical. EPM2000 meters can also be set into ratio mode with the press of a button.

Device Specifications

Model	EPM2000
Measurement Resolution	0.03% of full-scale
Rep. Rate Resolution	0.1 Hz
Max. Rep. Rate (pulsed energy measurement)	1,000 Hz (every pulse) 500 Hz (every pulse; ratio mode)
Power Sampling Rate 10 Hz	
Accuracy	
Digital Meter	±1.0% of reading
System	Meter accuracy + sensor accuracy
Analog Output	±1.0%
Display	2 large 4-digit fixed-segment LCDs w/backlight
Statistical Analysis	Min., max., mean, and standard deviation
Computer Interface	RS-232/IEEE-488 (GPIB)
Analog Output	0.00 to 2.00 VDC
Internal Trigger	2 to 20% of full scale, selectable
External Trigger Input	Rising/falling edge trigger via user control
Instrument Power	120 to 220 VAC, 50/60 Hz supply (internal)
Size (H x W x D)	305 x 305 x 114 mm (12.00 x 12.00 x 4.49 in.)
Weight (including batteries)	2.7 kg (5.9 lb.)
Part Number	
EPM2000[1]	0011-5140
EPM2000e[1]	0011-8231
RM-EPM Rack Mount Hardware (optional)	0011-5600

[1] Supplied with power cord, user manual, and certificate of calibration.

EPM2000



Top View

Front View

LaserCheck

Laser Power Meter

Features

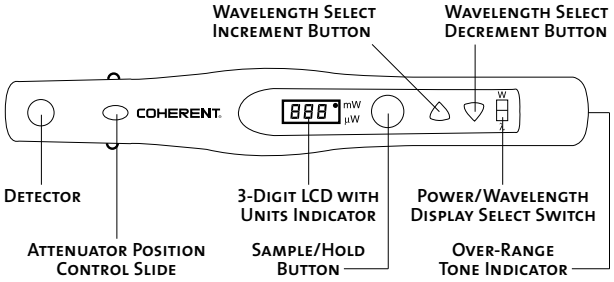
- Hand-held laser power meter
- Wavelength range: 400 to 1064 nm
- User-selectable spectral compensation
- Auto-ranging with peak sample and hold

Device Specifications

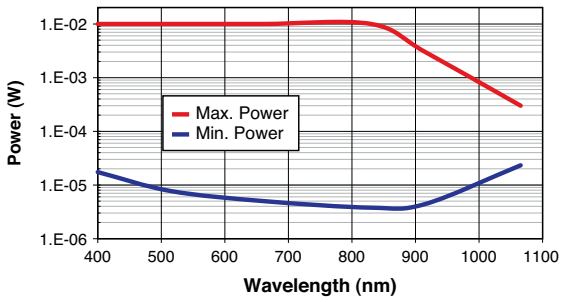
Model	LaserCheck
Active Area Diameter (mm)	8
Spectral Range (nm)	400 to 1064
Accuracy (%)	±5
Measurement Range[1]	
without Attenuator	10 µW to 10 mW
with Attenuator	1 mW to 1W
Display Power Ranges	9.99 µW to 999 mW
Minimum Power Resolution (µW)	0.01
Maximum Peak Power Density	
without Attenuator	0.5 W/cm²
with Attenuator	30 W/cm²
Display	3-digit LCD display with power unit indicator
Compliance	CE, WEEE, RoHS
Dimensions (H x W x D)	168 x 24 x 20 mm (6.6 x 0.9 x 0.7 in.)
Weight	44 g (0.09 lbs.)
Part Number (RoHS)	1098293

[1] Power range is wavelength dependent. See charts below. Ensure peak power density does not exceed limits to avoid localized diode saturation.

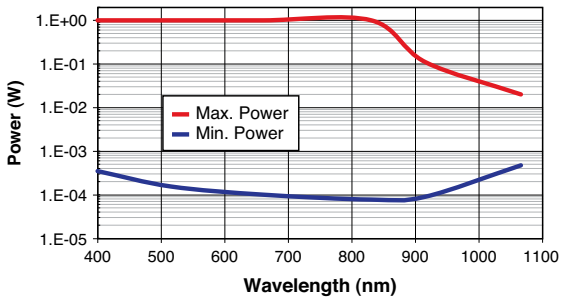
LaserCheck



Measurable Power vs. Wavelength
LaserCheck without Attenuator



Measurable Power vs. Wavelength
LaserCheck with Attenuator

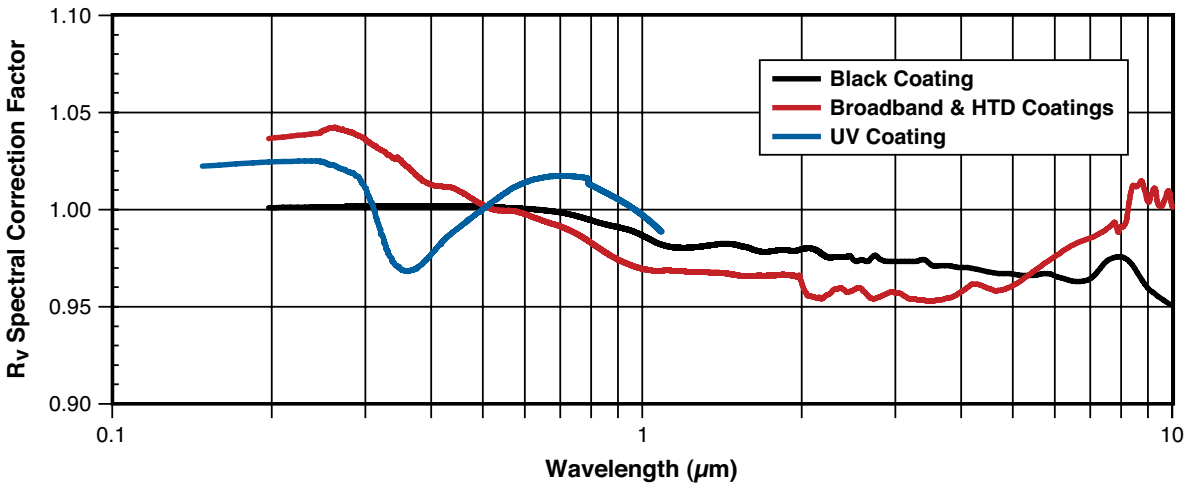


Power Sensors Introduction

Introduction and Selection Charts

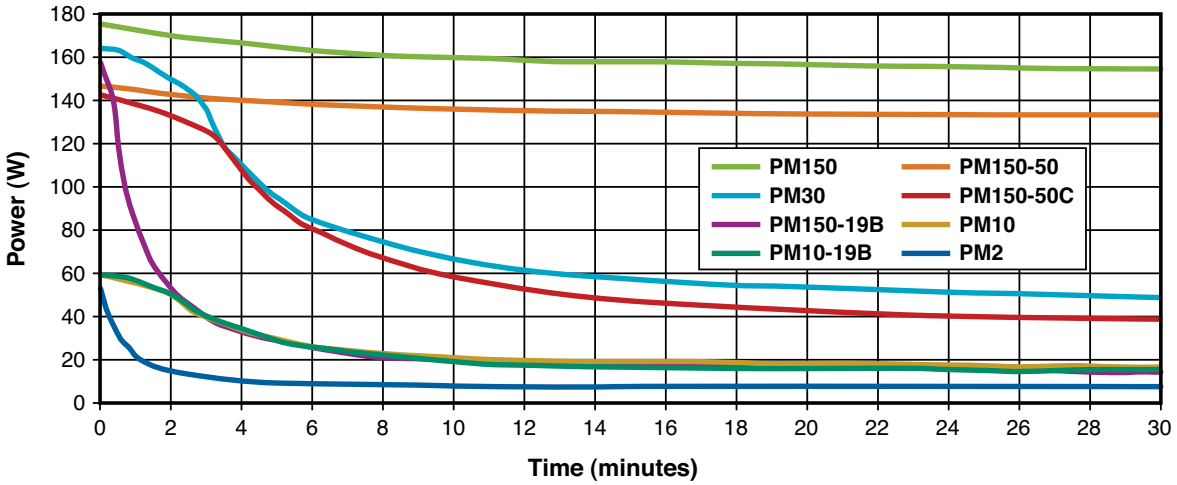
Coherent uses three primary coatings to capture the incident radiation on our thermal sensors. The specifications for each sensor list which coating is used. Typical wavelength ranges and response curves for these coatings are shown in the chart below. Each sensor contains a spectral curve generated from reflectance measurements taken with spectrometers. The reflectance data are converted into a wavelength compensation look-up table that is loaded into the sensor. This data is accessed by selecting a wavelength of operation in the meters.

R_V Spectral Correction for Thermal Sensors (normalized to 514 nm)



Many of our thermal sensors can measure power at levels greater than the maximum power rating for limited amounts of time. The following chart outlines how much power can be measured over a range of exposure times (Note: Water-cooled sensors are power-rated in air-cooled mode in this chart).

Exposure Limit vs. Power



Power Sensors Introduction

Long-Pulse Energy Measurement with a Thermopile

Models PM10-19C, PM150-50C and PM150-50XC

Application Example 1

Laser Pulse Width	50 ms
Maximum Energy	10J
Solution	Choose a PM10

Application Example 2

Laser Pulse Width	300 ms
Maximum Energy	80J
Solution	Choose a PM150 or PM150-50C*

* Specific sensor choice depends upon aperture and mechanical constraints.

Thermopile sensors are most commonly used for average power measurements on pulsed and CW lasers. Thermopiles are also capable of integrating long pulse widths. This allows the thermopile to measure the energy of single pulses between 1 millisecond and 10 seconds in length, and with energies from millijoules to hundreds of Joules. Long-pulse measurement is only possible when the thermopiles are used in conjunction with LabMax-TOP, LabMax-TO, or FieldMaxII-TOP meters, or when using a PowerMax-USB/RS sensor.

This ability to integrate relatively long laser pulses with a thermopile is necessary when the laser pulse width exceeds the maximum pulse width rating of pyroelectric sensors. Pyroelectric sensors are typically limited to maximum pulse widths in the millisecond range. When the pulse width exceeds milliseconds, a thermopile is a good solution.

A good "rule of thumb" for using a thermopile for this type of measurement is to compare the maximum pulse energy you need to measure with the maximum power rating of a sensor (maximum power ratings can be found in the Power Sensor Summary Specifications on pages 32 to 33 or in the detailed product specifications contained on pages 34 to 44).

Common applications for this type of measurement are in the medical field, especially skin resurfacing and hair removal, and in material processing applications such as laser welding. These laser systems often utilize high-energy diode lasers that have large beam sizes and relatively long pulses. A detector like the PM150-50C is ideal for these measurements. It features a large 50 mm aperture size, can handle pulse energies up to 150J, and can be used air-cooled for single pulse energy measurements (a PM150-50C will normally need to be water-cooled for continuous power measurements).

Using a LabMax power/energy meter, or a PowerMax-USB/RS sensor, expands the range of long-pulse Joule measurements down into the low millijoule level when used with thermopiles such as the PS10, PS10Q, PS19, and PS19Q sensors.

Long-pulse measurements are limited to single pulses in order to achieve the most accurate measurements.

PowerMax-USB/RS Sensors

Product Overview

Models LM-45, LM-10 and LM-3

Coherent PowerMax-USB sensors provide plug and play laser power measurement directly on a PC without the need for additional electronic instrumentation. The measurement circuitry typically found in a standalone meter has been reduced in size to the extent that it can now fit inside a USB connector. The circuitry and USB connector have been adapted into a 'PowerMax-USB' cable that can be integrated to most Coherent power sensors providing accurate power measurements of all types of CW and pulsed sources from the UV to Far IR.

This measurement platform can also be used to measure the energy in a long laser pulse (typically greater than 1 millisecond in pulse width) by integrating the output of a thermopile sensor.

The PowerMax-RS sensors incorporate the same circuitry inside an RS-232 connector to provide a convenient platform for integrating power measurement inside laser processing systems that often incorporate RS-232 inputs instead of USB.

PowerMax-USB Connector

Features

- **PowerMax-USB provides direct USB 2.0 connection to PC. Power provided via USB connection. Software and driver is compatible with Microsoft XP, Vista (32-bit and 64-bit), and Windows 7 (32-bit and 64-bit). The driver is qualified and signed by Microsoft.**
- **PowerMax-RS provides RS-232 connectivity. Power input provided via +5 VDC input.**
- **Instrumentation platform is compatible with thermopiles and optical sensors**
- **Displays beam position with position-sensing quadrant thermopiles (with LM-model sensors like LM-10)**
- **High resolution 24-bit A/D converter supports measurement accuracy equivalent to that found in Coherent's top-of-the-line LabMax meter**
- **Four digits of measurement resolution**
- **Sensors include spectral compensation for accurate use at wavelengths that differ from the calibration wavelength. Each device receives a unique spectral compensation curve specific to the absorption of its specific element, as well as transmission characterization of any associated optics.**
- **Thermopile sensors include a speed-up algorithm that speeds up the natural response of the thermopile detector without overshoot**
- **LED status indicators inside USB and RS-232 connectors provide health-and-status information**
- **Long pulse joules capability using thermopile sensors**

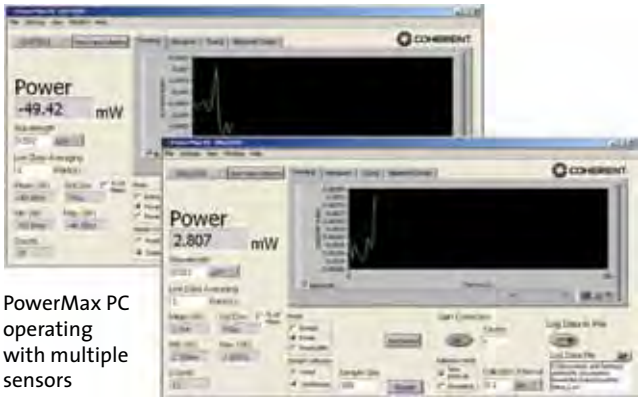
PowerMax-USB/RS Sensors

Product Overview

Software Features

PowerMax PC applications software is supplied free with sensor and includes the following features:

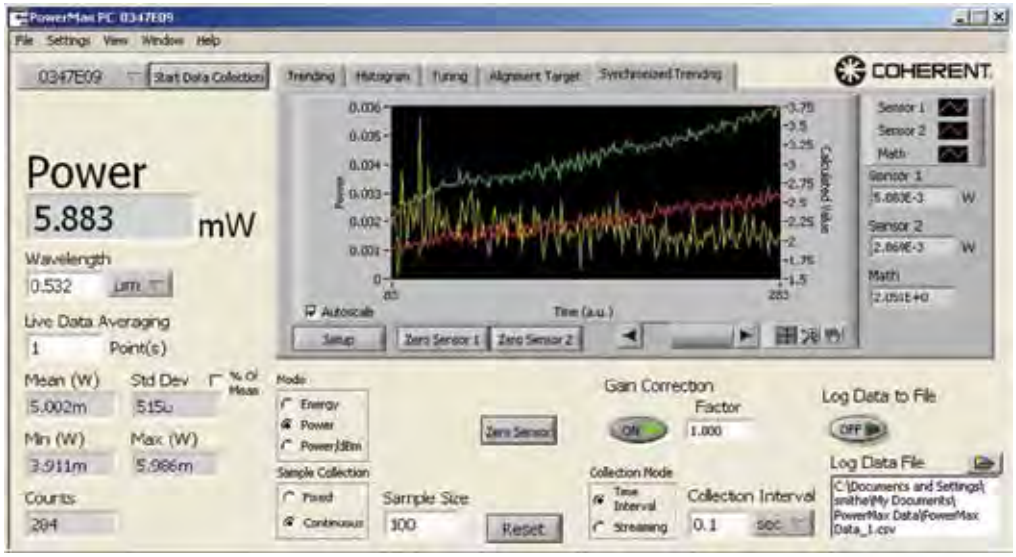
- **Trending, tuning, histogram**
- **Statistics (mean, minimum, maximum, and standard deviation) and log batch to file**
- **Display beam position on position-sensing thermopiles and log results to file**
- **Operate multiple devices simultaneously and perform synchronized ratiometery (A/B analysis). Trend and log results to file.**



PowerMax PC operating with multiple sensors

For system integration and for implementations involving customer written software the sensors provide an in depth command set that is easy to access:

- **DLL driver supports simple ASCII host commands for remote interfacing using both USB and RS-232 sensors**
- **National Instruments LabVIEW drivers are supplied for easy LabVIEW integration**



PowerMax PC in synchronized ratiometric trending mode

Coherent has two main types of thermopile sensors. The "LM Model" line utilizes a unique thermopile disk in which the thermocouples are split into four quadrants, allowing the sensors to provide beam position information in addition to power measurement. The "PM Model" line incorporates traditional thermopile disks that provide power measurement without beam position information. Both types of sensors can be used with the PowerMax-USB and PowerMax-RS sensors.

Quad Positioning Enabled

PowerMax-USB/RS Sensors

Applying Wavelength Compensation Accuracy

Overall measurement accuracy is a combination of calibration uncertainty (found in the sensor specification tables) and the wavelength compensation accuracy (found in the "Wavelength Compensation Accuracy" table, below).

The combined accuracy is based upon practices outlined in the National Institute of Standards Guidelines for Evaluating and Expressing Uncertainty (NIST Technical Note 1297, 1994 Edition). The combined accuracy of the measurement is calculated by using the law of propagation of uncertainty using the "root-sum-of-square" (square root of the sum of squares), sometimes described as "summing in quadrature" where:

$$\text{Measurement Accuracy} = \sqrt{U^2 + W^2}$$

where U = 'Percent Calibration Uncertainty' and W = 'Wavelength Accuracy'

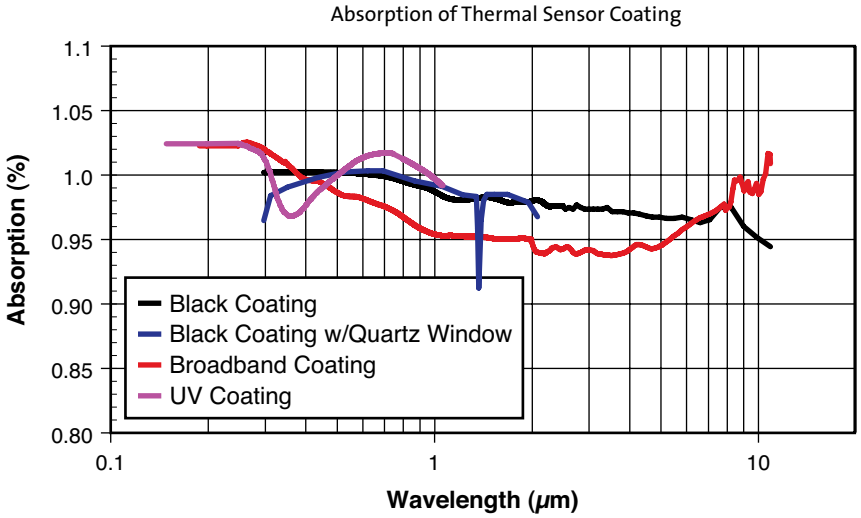
Example:

PowerMax-USB LM-10 used at 1064 nm

U = 2%
W = 1.5%

$$\text{Measurement Accuracy} = \sqrt{2^2 + 1.5^2} = \sqrt{4 + 2.3} = 2.5\%$$

Coherent uses three primary coatings to capture the incident radiation on our thermal sensors. The specifications for each sensor list which coating is used. Typical wavelength ranges and response curves for these coatings are shown in the chart below. Each sensor contains a spectral curve generated from reflectance measurements taken with spectrometers. The reflectance data are converted into a wavelength compensation look-up table that is loaded into the sensor. This data is accessed by selecting a wavelength of operation in the software.



Wavelength Compensation Accuracy

Sensor	Wavelength Compensation Accuracy (%)	Calibration Wavelength (nm)
All PM-model and LM-model thermopiles	±1.5	10,600
PS-model	±1.5	514
UV/VIS optical sensor	±4% (325 nm to 900 nm) ±5% (900 nm to 1065 nm)	514

PowerMax-USB/RS Sensors

100 µW to 2W

Models PS10, PS19Q, PM3

Features

- **Thermally stabilized design for low power sensitivity**
- **Noise equivalent power down to 3 µW**
- **Spectrally flat; good for broadband light sources**

The PS10 and PS19 model sensors are thermally stabilized, amplified thermopile power sensors with a broad spectral response, high sensitivity, and a large active area. These sensors are ideal for measuring laser diodes, HeNe and HeCd lasers, and small ion lasers. The PS10 model includes a light tube mounted to the front of the housing, which minimizes the effects of background radiation. The light tube can be removed and replaced by FC or SMA fiber connectors (see Accessories - page 31). Where optimum stability is required, specify the PS19Q, which include a wedged quartz window for applications from 0.3 to 2.1 µm. The quartz window more effectively eliminates thermal background radiation and the effects of air currents.

Device Specifications

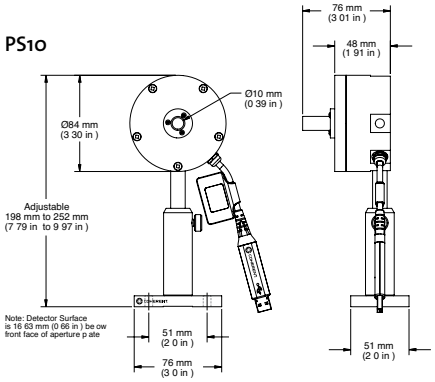
Model	PS10	PS19Q	PS19	PM3
Wavelength Range (nm)	190[3] to 11,000	300 to 2100	190[3] to 11,000	190[3] to 11,000
Power Range	100 µW to 1W	100 µW to 1W	100 µW to 1W	500 µW to 2W
Max. Intermittent Power (W)(<5 min.)	3			
Long-pulse Joules (J)	0.001 to 1			
Noise Equivalent Power (µW)	3	3	5	20
Maximum Thermal Drift[1] (µW)	±40	±25	±400	±1000
Maximum Power Density (W/cm²)	500			
Maximum Energy Density (mJ/cm²)	50 (10 ns, 1064 nm)			
Response Time (sec.)(0% to 95%)				
Speed-up On	1.7	1.6	1.6	1.9
Speed-up Off	3.6	3.0	3.0	4.1
Detector Coating	Black			
Detector Element	Thermopile			
Optic	None	Quartz	None	None
Detector Diameter (mm)	10	19	19	19
Calibration Uncertainty (%)	±2			
Power Linearity (%)	±1			
Spectral Compensation Accuracy (%)	±1.5			
Long-pulse Joules Accuracy (%)	±3			
Calibration Wavelength (nm)	514	514	514	10,600
Cooling Method	Air			
Cable Type	USB			
Cable Length (m)	2.5			
Part Number[2]	1174260	1168343	1174261	1174263

[1] Power stability over 30 minutes in typical lab environment.

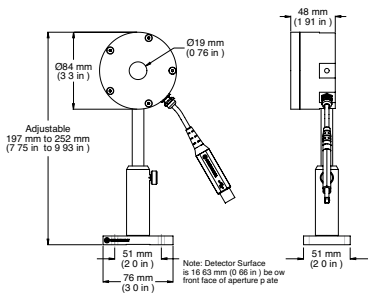
[2] Software and post stand included.

[3] 190 nm to 300 nm operation restricted to <100 mW average power and <250 W/cm² power density.

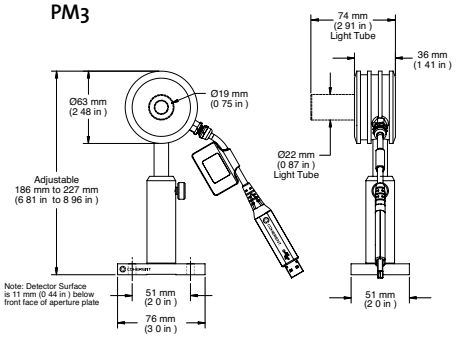
PS10



PS19Q/PS19



PM3



PowerMax-USB/RS Sensors

5 µW to >100 mW

Model UV/VIS

Features

- **Large 10 mm aperture**
- **High-sensitivity Silicon photodiode**
- **Low power measurements down to 5 µW (wavelength dependent)**
- **Spectral response from 325 nm to 1065 nm**

The PowerMax-USB UV/VIS Quantum sensor incorporates a Silicon photodiode, for measurement of power from 5 µW to several hundred milliwatts. The measureable power varies significantly by wavelength. See the chart on the next page.

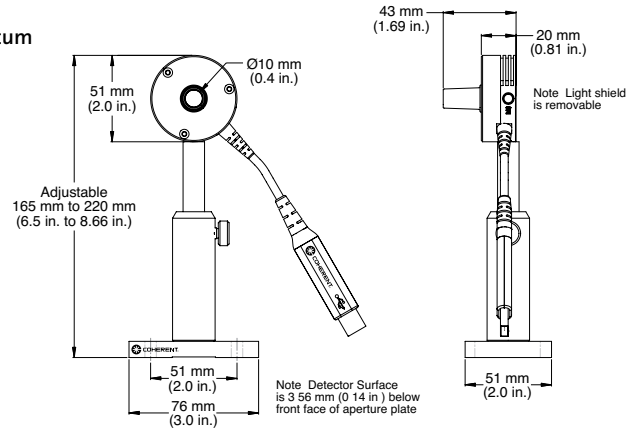
A spectrally calibrated ND2 filter is used to attenuate the laser beam, thus allowing for a higher average power measurement than is typically possible with a photodiode. The sensor works with CW (continuous wave) as well as pulsed sources greater than 100 pps, and has a removable nose cone that can be used to reduce stray light which is helpful when measuring on the low end of the power range.

Device Specifications

Model	UV/VIS
Wavelength Range (nm)	325 to 1065
Power Range	5 µW to >100 mW (wavelength dependent, see chart on page 7)
Noise Equivalent Power (nW)	100
Maximum Power Density (W/cm²)	20
Response Time (sec.)	
Speed-up On	-
Speed-up Off (0% to 100%)	0.1
Detector Element	Silicon photodiode
Optic	ND2
Detector Diameter (mm)	10
Calibration Uncertainty (%)	±2
Power Linearity (%)	±1
Spectral Compensation Accuracy (%)	±4 (325 to 900 nm) ±5 (900 to 1065 nm)
Calibration Wavelength (nm)	514
Cooling Method	Air
Cable Type	USB
Cable Length (m)	2.5
Part Number[1]	1168337

[1] Software and post stand included.

UV/VIS Quantum



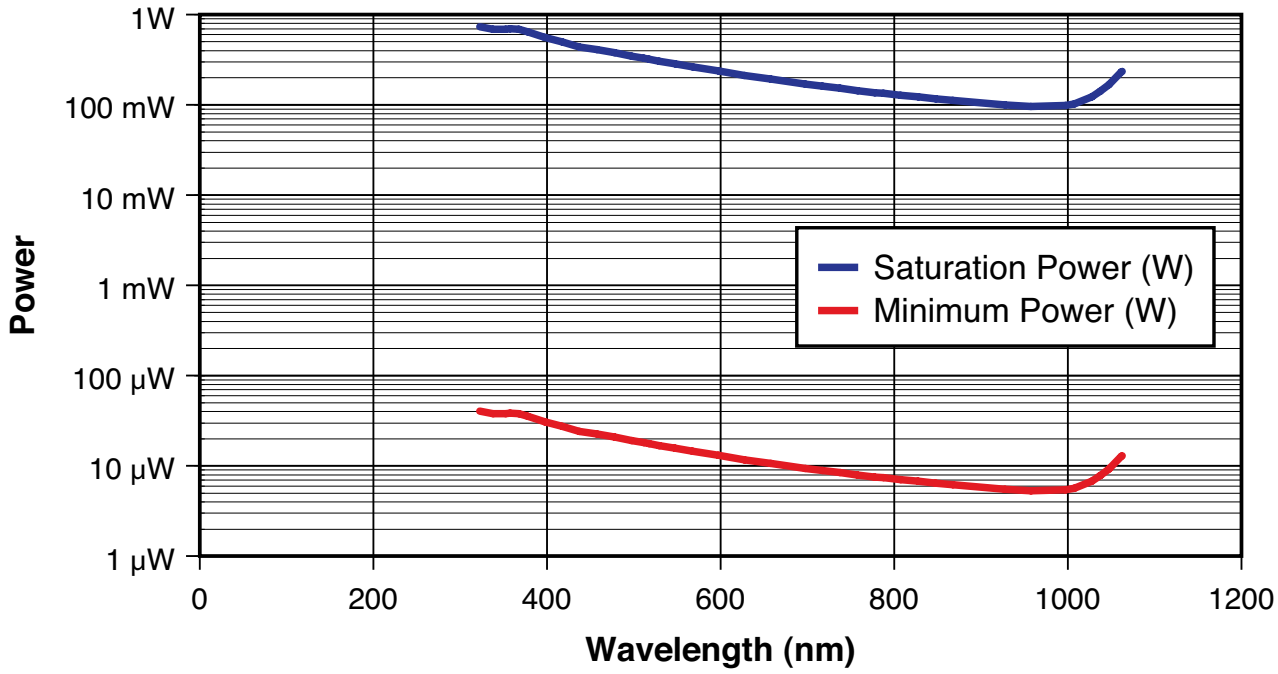
PowerMax-USB/RS Sensors

UV/VIS Quantum Overview

We incorporate spectral compensation in the PowerMax-USB UV/VIS sensor to provide accurate measurements across the 325 to 1065 nm spectrum. Because the spectral response of the ND filter and photodiode varies significantly across this wavelength range it is important to check the maximum measureable power at the wavelength of use to make sure the sensor is not being saturated.

The following curve plots the maximum measurable power, which is the saturation level of the photodiode, as well as the minimum recommended power level, by wavelength.

Saturation and Minimum Power
UV/VIS Sensors Over Wavelength



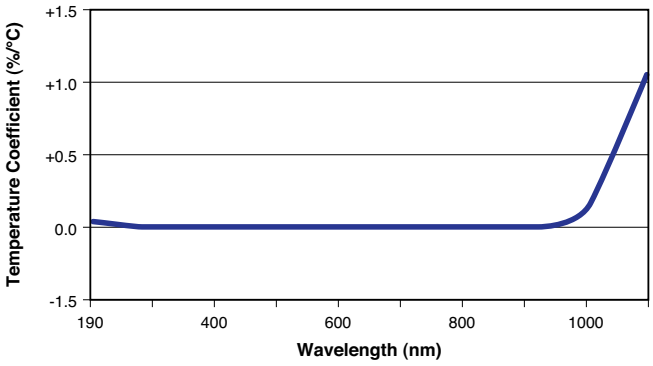
Measurement Linearity
Like all silicon photodiodes, the UV/VIS Quantum sensor has temperature sensitivity in the infrared region.

At 1064 nm, for example, it has a 0.5%/°C thermal coefficient. Measurement error of up to 2% are present at 1064 nm after a 10 minute warm-up time due to the electronics inside the sensor, and additional error can be present if the ambient measurement environment differs from the calibration wavelength listed on the calibration certificate.

In practice, wavelengths shorter than 1000 nm have insignificant effects due to temperature.

See the chart below to reference the thermal coefficient at the wavelength of use.

Photo Sensitivity Temperature Characteristic



PowerMax-USB/RS Sensors

10 mW to 25W

Models LM-45, LM-10, LM-3

Features

- **Thermopile detector element for high power measurements**
- **Measures beam position on detector surface**
- **Noise equivalent power down to 0.4 mW**
- **Large 16 and 19 mm apertures**

Quad Positioning Enabled

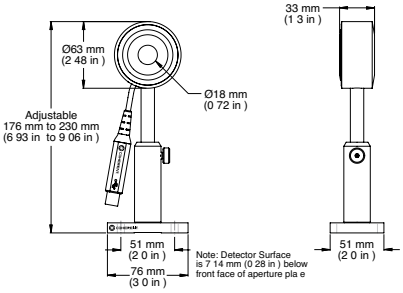
Thermopile sensors are a great all-purpose technology suitable for many lasers. They are used for measuring CW laser power, average power in pulsed lasers, and are often used to integrate the energy of long pulses. Thermopiles operate across a wide range of input powers, and unlike a photodiode-based sensor they will not saturate. These unique thermopiles incorporate a quadrant thermopile detector disk that enables them to sense the position of the laser beam on the detector surface while measuring the laser power. Fiber optic adapters are available on page 31.

Device Specifications

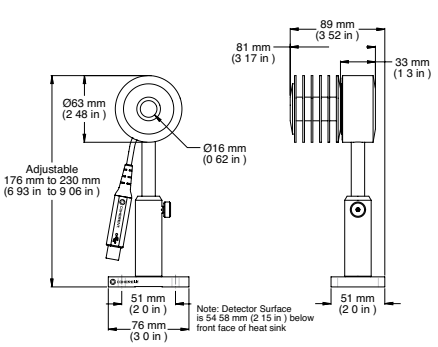
Model	LM-3	LM-10	LM-45
Wavelength Range (µm)		0.25 to 10.6	
Power Range	10 mW to 3W	10 mW to 10W	100 mW to 25W
Max. Intermittent Power (W)(<5 min.)	10	12	45
Long-Pulse Joules (J)	0.5 to 10	0.5 to 10	0.5 to 50
Noise Equivalent Power (mW)	0.4	0.4	2
Maximum Power Density (kW/cm²)		6	
Maximum Energy Density (mJ/cm²)		600 (10 ns, 1064 nm)	
Response Time (sec.)(0% to 95%)			
Speed-up On	1.6	1.6	2.6
Speed-up Off	3.5	3.5	3.9
Detector Coating		Broadband	
Detector Element		Thermopile	
Optic		None	
Detector Diameter (mm)	19	16	19
Calibration Uncertainty (%)		±2	
Power Linearity (%)		±1	
Spectral Compensation Accuracy (%)		±1.5	
Long-Pulse Joules Accuracy (%)		±3	
Calibration Wavelength (nm)		10,600	
Cooling Method		Air	
Cable Type		USB	
Cable Length (m)		2.5	
Part Number[1]	1168339	1168340	1168342

[1] Software and post stand included.

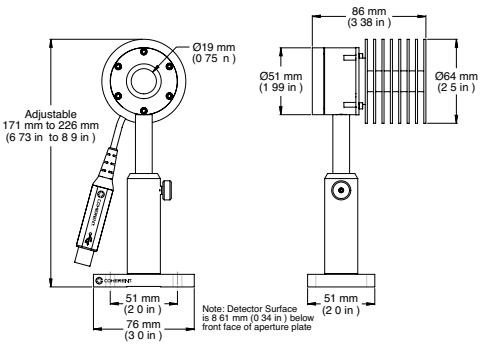
LM-3


Ø63 mm (2 48 in)
Ø18 mm (0 72 in)
Adjustable 176 mm to 230 mm (6 93 in to 9 06 in)
33 mm (1 3 in)
51 mm (2 0 in)
76 mm (3 0 in)
51 mm (2 0 in)
Note: Detector Surface is 7 14 mm (0 28 in) below front face of aperture pla e

LM-10


Ø63 mm (2 48 in)
Ø16 mm (0 62 in)
Adjustable 176 mm to 230 mm (6 93 in to 9 06 in)
89 mm (3 52 in)
81 mm (3 17 in)
33 mm (1 3 in)
51 mm (2 0 in)
76 mm (3 0 in)
51 mm (2 0 in)
Note: Detector Surface is 54 58 mm (2 15 in) below front face of heat sink

LM-45


Ø19 mm (0 75 n)
Adjustable 171 mm to 226 mm (6 73 in to 8 9 in)
86 mm (3 38 in)
Ø51 mm (1 99 in)
Ø64 mm (2 5 in)
51 mm (2 0 in)
76 mm (3 0 in)
51 mm (2 0 in)
Note: Detector Surface is 8 61 mm (0 34 in) below front face of aperture plate

PowerMax-USB/RS Sensors

1W to 1 kW

Models LM-1000, PM1K-36C

Features

- **Water-cooled**
- **Spectrally flat from 0.25 µm to 10.6 µm**
- **LM-1000 measures beam position**
- **36 mm to 38 mm apertures**

Quad Positioning Enabled (LM-1000 only)

These kilowatt thermopile sensors are water-cooled for measuring laser output up to 1 kW and are excellent for use with CO_2 and Nd:YAG lasers.

Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details). See page 31 for RS model power supply accessory.

Device Specifications

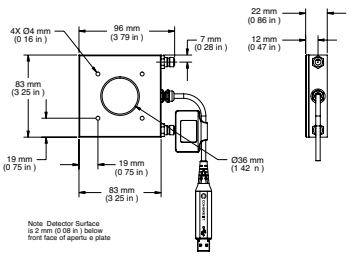
Model	PM1K-36C	LM-1000
Wavelength Range (µm)	0.25 to 10.6	0.25 to 10.6
Power Range (W)	1 to 1000	1 to 1000
Noise Equivalent Power (mW)	20	
Maximum Power Density[1] (kW/cm²)	1 to 2.5	
Maximum Energy Density (mJ/cm²)	500	
Response Time (sec.)(0% to 95%)		
Speed-up On	2.3	3.5
Speed-up Off	6.0	6.1
Detector Coating	Broadband	
Detector Element	Thermopile	
Detector Diameter (mm)	36	38
Calibration Uncertainty (%)	±5	
Power Linearity (%)	±1	
Spectral Compensation Accuracy (%)	±1.5	
Calibration Wavelength (nm)	10,600	
Cooling Method	Water	
Cable Type	USB and RS	
Cable Length (m)	2.5 (USB), 0.3 (RS)	
Part Number[2]	1174266 (USB) 1174267 (RS)	1174268 (USB)

[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

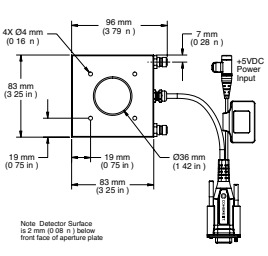
[2] Software and water fittings included for both models and post stand included with LM-1000.

PM1K-36C

USB

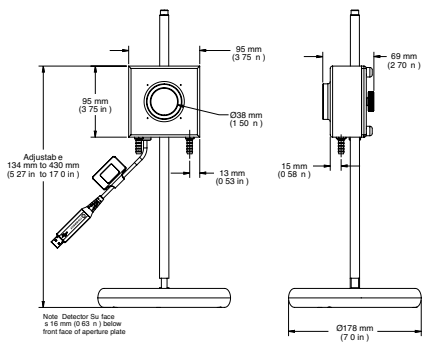

4X Ø4 mm (0 16 in)
96 mm (3 79 in)
7 mm (0 28 in)
22 mm (0 86 in)
12 mm (0 47 in)
83 mm (3 25 in)
19 mm (0 75 in)
19 mm (0 75 in)
Ø36 mm (1 42 in)
83 mm (3 25 in)
Note Detector Surface is 2 mm (0 08 in) below front face of aperture plate

RS


4X Ø4 mm (0 16 in)
96 mm (3 79 in)
7 mm (0 28 in)
+5VDC Power Input
83 mm (3 25 in)
19 mm (0 75 in)
19 mm (0 75 in)
Ø36 mm (1 42 in)
83 mm (3 25 in)
Note Detector Surface is 2 mm (0 08 in) below front face of aperture plate

LM-1000

USB


95 mm (3 75 in)
95 mm (3 75 in)
Ø38 mm (1 50 in)
13 mm (0 53 in)
Adjustable 134 mm to 430 mm (5 27 in to 17 0 in)
69 mm (2 70 in)
15 mm (0 58 in)
Note Detector Surface is 16 mm (0 63 in) below front face of aperture plate
Ø178 mm (7 0 in)

PowerMax-USB/RS Sensors

5 mW to 30W

Models PM2, PM10, PM30

Features

- **Convective air-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **Noise equivalent power down to 0.2 mW**
- **19 mm aperture**

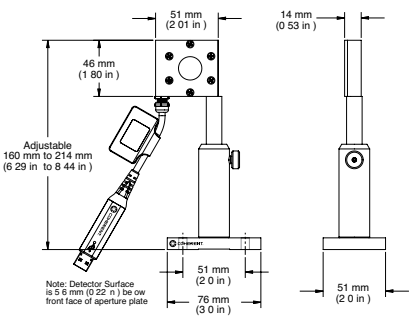
These thermopile sensors are used to measure CW and pulsed lasers from 5 mW up to 30W average power output. These sensors are able to dissipate heat via convection cooling, which makes them convenient to use.

Device Specifications

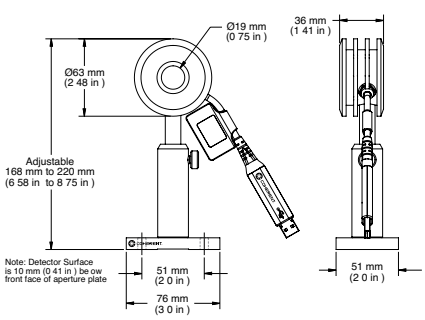
Model	PM2	PM10	PM30
Wavelength Range (µm)		0.19 to 11	
Power Range	5 mW to 2W	5 mW to 10W	10 mW to 30W
Long-Pulse Joules Range (J)	0.5 to 2	0.5 to 10	0.5 to 50
Max. Intermittent Power (<5 min.)(W)	5	30	50
Noise Equivalent Power (mW)	0.2	0.2	0.5
Maximum Power Density (kW/cm²)		6	
Maximum Energy Density (mJ/cm²)		600 (10 ns, 1064 nm)	
Response Time (sec.)(0% to 95%)			
Speed-up On	1.9	1.8	2.3
Speed-up Off	3.4	3.4	3.6
Detector Coating		Broadband	
Detector Element		Thermopile	
Optic		None	
Detector Diameter (mm)		19	
Calibration Uncertainty (%)		±2	
Power Linearity (%)		±1	
Spectral Compensation Accuracy (%)		±1.5	
Long-Pulse Joules Accuracy (%)		±3	
Calibration Wavelength (nm)		10,600	
Cooling Method		Air	
Cable Type		USB	
Cable Length (m)		2.5	
Part Number[1]	1174264	1174262	1174257

[1] Software and post stand included.

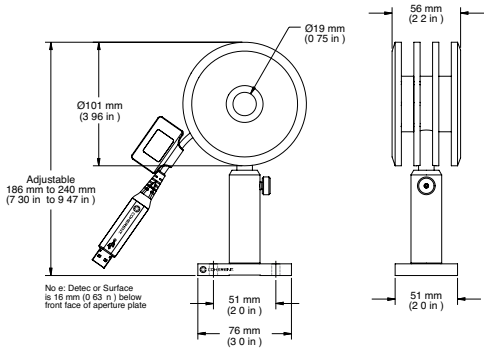
PM2



PM10



PM30



PowerMax-USB/RS Sensors

10 mW to 150W

Models PM10-19C, PM150-19C, PM150-50C

Features

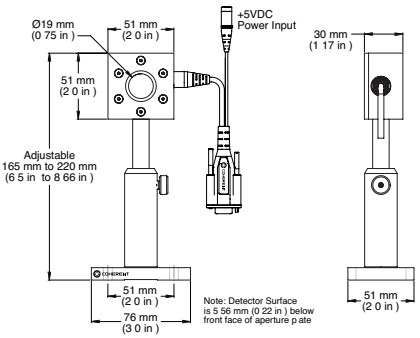
- **Water-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **Noise equivalent 0.2 mW to 1 mW**
- **19 mm and 50 mm apertures**

These compact sensors are ideal in tight spaces, but must be water-cooled in order to achieve their full power specification during continuous operation. They can also be mounted to a heat sink or used standalone for intermittent use without water-cooling. Tap or distilled cooling water is recommended at a flow rate of 0.2 gallons per minute with these sensors – DI water can not be used. These sensors are also very useful for air-cooled energy measurement of long-pulse (>1 ms) lasers using the long-pulsed Joules mode. See page 31 for RS model power supply accessory. Water fittings are included.

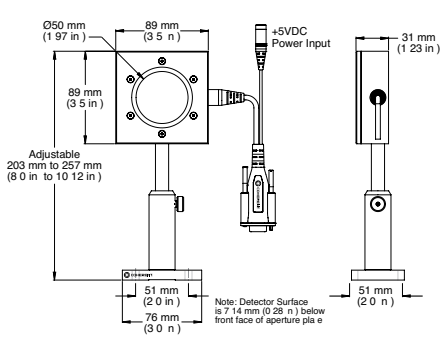
Device Specifications

Model	PM10-19C	PM150-19C	PM150-50C
Wavelength Range (µm)		0.19 to 11	
Power Range (water-cooled)	10 mW to 10W	300 mW to 150W	300 mW to 150W
Max. Intermittent Power (W)(<5 min.)	5 (air-cooled)	20 (air-cooled)	80 (air-cooled)
Long-Pulse Joules (J)	0.5 to 10	1 to 150	1 to 150
Noise Equivalent Power (mW)	0.2	1	1
Maximum Power Density (kW/cm²)		6	
Maximum Energy Density (mJ/cm²)		600 (10 ns, 1064 nm)	
Response Time (sec.)(0% to 95%)			
Speed-up On	1.7	2.1	2.9
Speed-up Off	3.4	3.2	11.9
Detector Coating		Broadband	
Detector Element		Thermopile	
Optic		None	
Detector Diameter (mm)	19	19	50
Calibration Uncertainty (%)		±2	
Power Linearity (%)		±1	
Spectral Compensation Accuracy (%)		±1.5	
Long-Pulse Joules Accuracy (%)		±3	
Calibration Wavelength (nm)		10,600	
Cooling Method		Water/Air (intermittent)	
Cable Type		USB and RS	
Cable Length (m)		2.5 (USB)/0.3 (RS)	
Part Number	1168344 (USB) 1168345 (RS)	1168346 (USB) 1168347 (RS)	1168348 (USB) 1168349 (RS)

PM10-19C/PM150-19C (shown with PowerMax-RS cable)



PM150-50C (shown with PowerMax-RS cable)



PowerMax-USB/RS Sensors

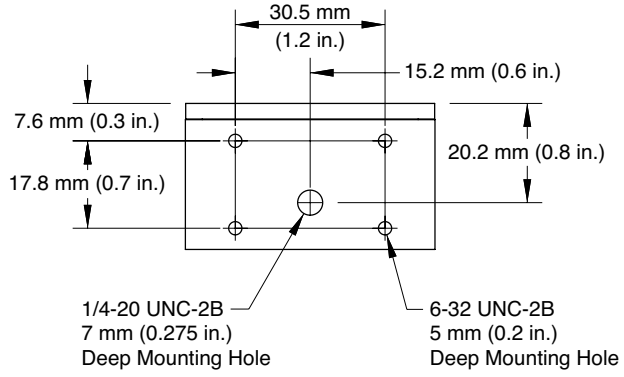
OEM Thermopiles Overview

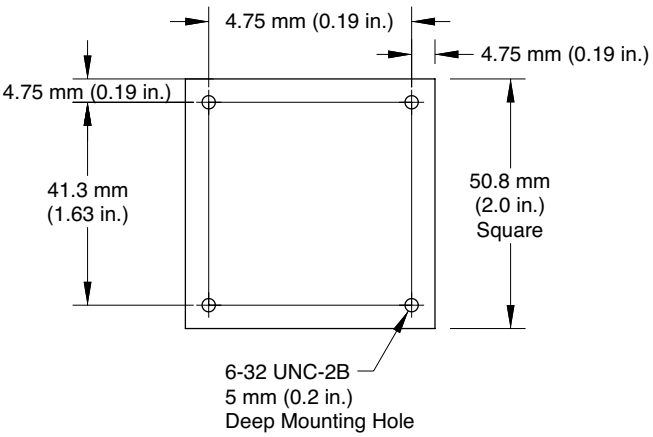
Models PM150-50C, PM150-19C

Unlike the PowerMax-USB that is powered through a PC's USB 2.0 connection, the PowerMax-RS sensors must powered externally with a +5 VDC power source. An external power supply may be plugged into the 6 mm barrel receptacle, or alternatively, for custom OEM installations power may be provided on Pin 1 through the DE-9 connector. Additional information concerning integration of the OEM thermopiles, including detailed housing drawings, can be found below.

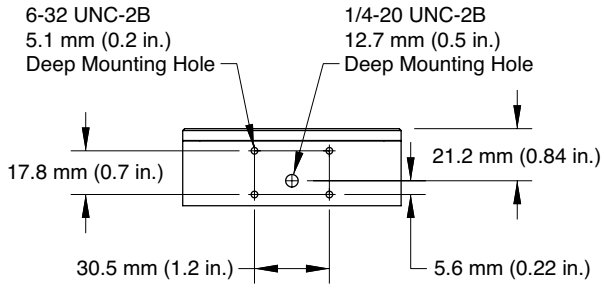
PowerMax-RS Information
PC Interface: RS-232
Connector: DE-9 female
Cable length: 300 mm. Use standard RS-232 cable to connect device to PC.
Communication: Pin 2 – Receive Data; Pin 3 – Transmit Data;
Pin 5 – Signal Ground
Required Power: +5 VDC ±5% with less than 100 mV RMS noise
Current draw: <300 mA
Power input connector: 6 mm barrel with 2 mm pin, center positive
Power supply: Optional equipment, order #1105557 for UL and
PSE certified power supply with power cord.
Alternate OEM power input: +5 VDC on Pin 1; Pin 5 – Ground
(shared with Signal Ground)

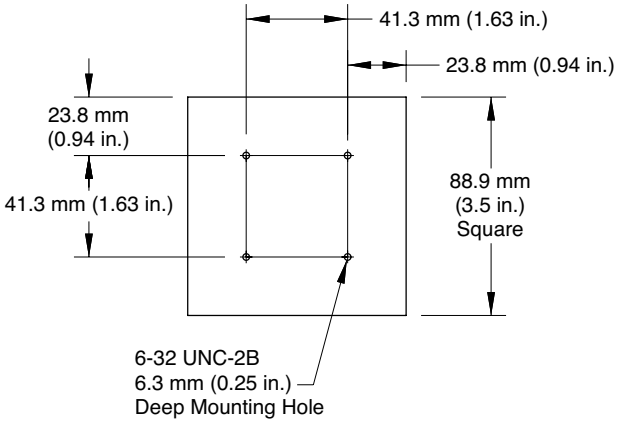
Mounting Hole Locations
PM10-19C/PM150-19C





PM150-50C





PowerMax-USB/RS Sensor Accessories

Fiber-Optic Connector Adapters

SMA and FC Adapters

The following fiber-optic adapters can be mounted directly onto the 3/4-32 threads on the front of LM-3 and LM-10 sensors. These fiber adapters can also be used with our 1.035-40M adapter ring to fit on the LM-45 sensor.

Part Number	Description	Sensors
1098589	SMA-Type Connector	LM-3, LM-10
1098339	FC/PC-Type Connector	LM-3, LM-10
33-9432-000	1.035-40M Adapter Ring	LM-45

SMA and FC Adapters

The following fiber adapters can be mounted onto the front of the PS10 sensor in place of the removable light tube.

Part Number	Description	Sensors
0012-3860	PS-SMA-Type Connector	PS10
0012-3863	PS-FC-Type Connector	PS10

PowerMax-RS Sensor Accessory

PowerMax-RS Sensor Power Supply

Part Number	Description	PowerMax-RS Sensor Models
1105557	5V External Power Supply	PM1K-36C, PM10-19C, PM150-19C, PM150-50C

Power Sensors Introduction

Summary of Specifications

Part Number	Description	Wavelength Range (µm)	Power Min.	Power Max.	Power Resolution	Long-Pulse Energy Range (J)	Detector Diameter (mm)	Detector Coating	Detector Type	Calibration Wavelength (nm)	Calibration Uncertainty (±%)	Connector
High-Sensitivity Semiconductor Sensors (to 50 mW)												
1098401	OP-2 UV	0.25 to 0.4	10 nW	30 mW	1 nW	–	6.0	–	Silicon	–	8	OP DB-25
1098313	OP-2 VIS	0.4 to 1.064	10 nW	30 mW	1 nW	–	7.9	–	Silicon	–	5	OP DB-25
1098416	OP-2 IR	0.8 to 1.8	10 nW	10 mW	1 nW	–	5.0	–	Germanium	–	4.5	OP DB-25
1098390	LM-2 UV	0.25 to 0.4	10 nW	30 mW	1 nW	–	6.0	–	Silicon	–	8	LM DB-25
1098298	LM-2 VIS	0.4 to 1.064	10 nW	30 mW	1 nW	–	7.9	–	Silicon	–	5	LM DB-25
1098342	LM-2 IR	0.8 to 1.55	10 nW	10 mW	1 nW	–	5.0	–	Germanium	–	4.5	LM DB-25
High-Sensitivity Thermopile Sensors (to 2W)												
1098350	PS10	0.19 to 11.0	100 µW	1W	10 µW	0.001 to 1	10	Black	–	514	1	PM DB-25
1098400	PS10Q	0.3 to 2.0	100 µW	1W	10 µW	0.001 to 1	10	Black	–	514	1	PM DB-25
1098413	PS19	0.19 to 11.0	100 µW	1W	10 µW	0.001 to 1	19	Black	–	514	1	PM DB-25
1098341	PS19Q	0.3 to 2.0	100 µW	1W	10 µW	0.001 to 1	19	Black	–	514	1	PM DB-25
1098336	PM3	0.19 to 11.0	500 µW	2W	50 µW	–	19	Black	–	514	1	PM DB-25
1098419	PM3Q	0.3 to 2.0	500 µW	2W	50 µW	–	10	Black	–	514	1	PM DB-25
Air-Cooled Thermopile Sensors (to 150W)												
1098329	PM2	0.19 to 11.0	10 mW	2W	1 mW	0.5 to 2	19	Broadband	–	514	1	PM DB-25
1098457	PM2X	0.15 to 1.0	10 mW	2W	1 mW	0.5 to 2	19	UV	–	514	1	PM DB-25
1097901	PM10	0.19 to 11.0	10 mW	10W	1 mW	0.5 to 10	19	Broadband	–	514	1	PM DB-25
1098423	PM10X	0.15 to 1.0	10 mW	10W	1 mW	0.5 to 10	19	UV	–	514	1	PM DB-25
1098314	PM30	0.19 to 11.0	100 mW	30W	10 mW	0.5 to 50	19	Broadband	–	514	1	PM DB-25
1098498	PM30X	0.15 to 1.0	100 mW	30W	10 mW	0.5 to 50	19	UV	–	514	1	PM DB-25
1098483	PM100-19C	0.19 to 11.0	300 mW	100W	30 mW	1 to 100	19	Broadband	–	514	1	PM DB-25
1098407	PM150	0.19 to 11.0	300 mW	150W	30 mW	1 to 150	19	Broadband	–	514	1	PM DB-25
1098398	PM150-50	0.19 to 11.0	300 mW	150W	30 mW	1 to 150	50	Broadband	–	514	1	PM DB-25
1098455	PM150X	0.15 to 1.0	300 mW	150W	30 mW	1 to 150	50	UV	–	514	1	PM DB-25
Water-Cooled Thermopile Sensors (to 300W)												
1098397	PM10-19C	0.19 to 11.0	10 mW	10W	1 mW	0.5 to 10	19	Broadband	–	514	1	PM DB-25
1098444	PM150-19C	0.19 to 11.0	300 mW	150W	30 mW	1 to 150	19	Broadband	–	514	1	PM DB-25
1098412	PM150-50C	0.19 to 11.0	300 mW	150W	30 mW	1 to 150	50	Broadband	–	514	1	PM DB-25
1098443	PM150-50XC	0.15 to 1.0	300 mW	150W	30 mW	1 to 150	50	UV	–	514	1	PM DB-25
1141474	PM300	0.19 to 11.0	1W	300W	0.1W	–	19	Broadband	–	514	1	PM DB-25
Fan-Cooled Thermopile Sensors (to 300W)												
1098480	PM200F-19	0.19 to 11.0	1W	200W	100 mW	1 to 200	19	Broadband	–	514	1	PM DB-25
1098472	PM200F-50	0.19 to 11.0	1W	200W	100 mW	1 to 200	50	Broadband	–	514	1	PM DB-25
1113493	PM200F-50X	0.15 to 1.0	1W	200W	100 mW	1 to 200	50	UV	–	514	1	PM DB-25
1098509	PM300F-19	0.19 to 11.0	1W	300W	100 mW	1 to 300	19	Broadband	–	514	1	PM DB-25
1098417	PM300F-50	0.19 to 11.0	1W	300W	100 mW	1 to 300	50	Broadband	–	514	1	PM DB-25
1098481	PM300F-50X	0.15 to 1.0	1W	300W	100 mW	1 to 300	50	UV	–	514	1	PM DB-25

Power Sensors Introduction

Summary of Specifications

Part Number	Description	Wavelength Range (µm)	Power Min.	Power Max.	Power Resolution	Long-Pulse Energy Range (J)	Detector Diameter (mm)	Detector Coating	Calibration Wavelength (nm)	Calibration Uncertainty (±%)	Connector
High-Power Water-Cooled Thermopile Sensors (to 5 kW)											
1098392	PM1K	0.19 to 11.0	100W	1000W	1W	–	50	Broadband	1064	5	PM DB-25
1098462	PM3K	0.19 to 11.0	100W	3000W	1W	–	50	Broadband	1064	5	PM DB-25
1098454	PM5K	0.19 to 11.0	100W	5000W	1W	–	50	Broadband	1064	5	PM DB-25
Large-Area High-Power Water-Cooled Thermopile Sensors (to 5 kW)											
1098490	PM1K-100	0.19 to 11.0	100W	1000W	1W	–	100	Broadband	1064	5	PM DB-25
1098506	PM3K-100	0.19 to 11.0	100W	3000W	1W	–	100	Broadband	1064	5	PM DB-25
1098461	PM5K-100	0.19 to 11.0	100W	5000W	1W	–	100	Broadband	1064	5	PM DB-25
1098505	PM5K-200	0.19 to 11.0	100W	5000W	1W	–	200	Broadband	1064	5	PM DB-25
Position-Sensing Air-Cooled Thermopile Sensors (to 200W)											
1098328	LM-3	0.25 to 10.6	10 mW	3W	1 mW	0.5 to 10	19	HTD	10600	2	LM DB-25
1098304	LM-10	0.25 to 10.6	10 mW	10W	1 mW	0.5 to 10	16	HTD	10600	2	LM DB-25
1098456	LM-20	0.25 to 10.6	100 mW	20W	10 mW	0.5 to 10	19	HTD	10600	2	LM DB-25
1098320	LM-45	0.25 to 10.6	100 mW	45W	10 mW	0.5 to 10	19	HTD	10600	2	LM DB-25
1098346	LM-100	0.25 to 10.6	100 mW	100W	10 mW	0.5 to 10	19	HTD	10600	2	LM DB-25
1098394	LM-150 FS	0.25 to 10.6	100 mW	150W	10 mW	0.5 to 10	19	HTD	10600	2	LM DB-25
1098452	LM-150 LS	0.25 to 10.6	100 mW	150W	10 mW	0.5 to 10	19	HTD	10600	2	LM DB-25
1098450	LM-200 220V	0.25 to 10.6	100 mW	200W	10 mW	0.5 to 100	19	HTD	10600	5	LM DB-25
1098440	LM-200 110V	0.25 to 10.6	100 mW	200W	10 mW	0.5 to 100	19	HTD	10600	5	LM DB-25
Position-Sensing Water-Cooled Thermopile Sensors (to 5 kW)											
1098409	LM-1000	0.25 to 10.6	100W	1000W	1W	–	38	Broadband	10600	5	LM DB-25
1098437	LM-2500	0.25 to 10.6	100W	2500W	1W	–	55	Broadband	10600	5	LM DB-25
1098421	LM-5000	0.25 to 10.6	100W	5000W	1W	–	55	Broadband	10600	5	LM DB-25
High-Peak-Power Thermopile Sensors (to 30W)											
1098338	PM10V1	0.25 to 3.0	10 mW	10W	1 mW	–	19	Volume Absorber	514	1	PM DB-25
1098429	PM30V1	0.25 to 3.0	100 mW	30W	10 mW	–	19	Volume Absorber	514	1	PM DB-25
Off-the-Shelf OEM Power Sensors (to 1 kW)											
1098334	PM10-19A	0.19 to 11.0	100 mW	10W	10 mW	–	19	Broadband	514	1	4-pin connector
1098343	PM10-19B	0.19 to 11.0	100 mW	10W	10 mW	–	19	Broadband	514	1	BNC-terminated
1098418	PM150-19A	0.19 to 11.0	300 mW	150W	30 mW	–	19	Broadband	514	1	4-pin connector
1098321	PM150-19B	0.19 to 11.0	300 mW	150W	30 mW	–	19	Broadband	514	1	BNC-terminated
1098510	PM150-50A	0.19 to 11.0	300 mW	150W	30 mW	–	50	Broadband	514	1	4-pin connector
1098415	PM150-50B	0.19 to 11.0	300 mW	150W	30 mW	–	50	Broadband	514	1	BNC-terminated
1098441	PM150-50XB	0.15 to 1.0	300 mW	150W	30 mW	–	50	UV	514	1	BNC-terminated
1098333	PM1K-36B	0.19 to 11.0	100W	1000W	1W	–	36	Broadband	1064	5	BNC-terminated
1098427	BeamFinder	0.25 to 10.6	100W	1000W	1W	–	35	Broadband	10600	5	LM DB-25

Beam Position Sensing Thermopile Sensors

10 mW to 45W

Models LM-3, LM-10, LM-45

Features

- **Spectrally flat from 0.19 to 11 µm**
- **10 mW to 100 mW resolution**
- **16 mm to 19 mm apertures**
- **FC and SMA fiber connectors available (see page 51)**

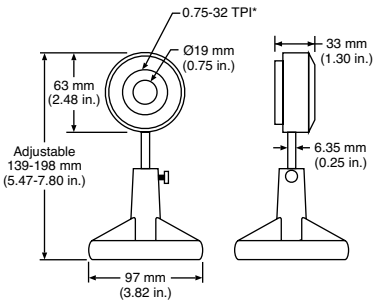
Use with LabMax (see page 10)

These unique thermopiles incorporate a quadrant thermopile disk that enables them to sense the position of the beam on the detector surface. This information is displayed by meters such as LabMax. All Coherent products which incorporate this position sensing technology are identified with the logo shown on the right.

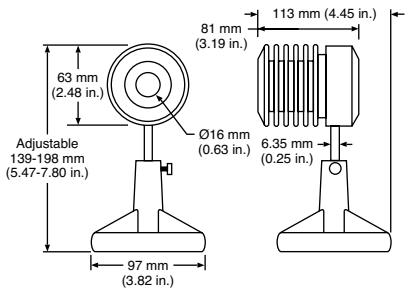
Device Specifications

Model	LM-3	LM-10	LM-45
Wavelength Range (µm)		0.25 to 10.6	
Power Range	10 mW to 3W	10 mW to 10W	100 mW to 45W
Long-Pulse Joules Range (J)		0.5 to 10	
Resolution (mW)		1	100
Max. Power Density		6 kW/cm²	
Max. Energy Density		0.5 J/cm², 1064 nm, 10 ns	
Detector Coating		HTD	
Detector Diameter (mm)	19	16	19
Dimensions (mm)	Ø63 X 33 (2.4 x 1.2 in.)	Ø63 X 81 (2.4 x 3.1 in.)	Ø64 X 86 (2.5 x 3.3 in.)
Calibration Uncertainty (%)		±2	
Calibration Wavelength (µm)		10.6	
Cooling Method		Air-cooled	
Cable Type		LM DB-25	
Cable Length (m)		1.8	
Part Number	1098328	1098304	1098320

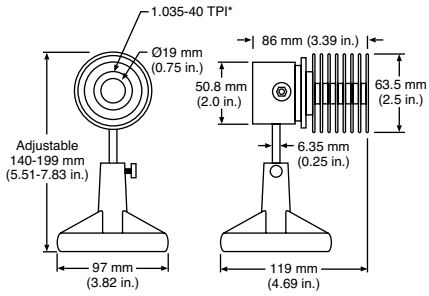
LM-3



LM-10



LM-45



* Threads per inch

Beam Position Sensing Thermopile Sensors

100 mW to 200W

Models LM-100, LM-200

Features

- **Spectrally flat from 0.19 to 11 µm**
- **10 mW resolution**
- **19 mm apertures**
- **FC and SMA fiber connectors available (see page 51)**

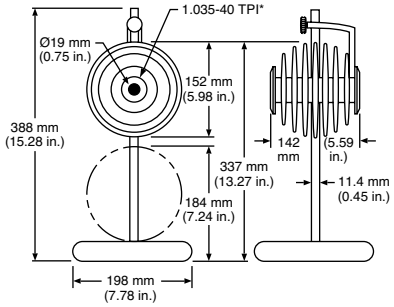
Use with LabMax (see page 10)

The LM-100 sensor is convectively-cooled for powers up to 100W. The LM-200 sensor is fan-cooled and is available in 110 VAC and 220 VAC configurations. Water fittings are included.

Device Specifications

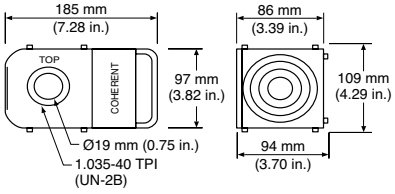
Model	LM-100	LM-200
Wavelength Range (µm)	0.25 to 10.6	
Power Range (water-cooled)	100 mW to 100W	100 mW to 200W
Long-Pulse Joules Range (J)	0.5 to 10	
Resolution (mW)	10	
Max. Power Density	6 kW/cm²	
Max. Energy Density	0.5 J/cm², 1064 nm, 10 ns	
Detector Coating	HTD	
Detector Diameter (mm)	19	
Dimensions (mm)	Ø152 x 142 (5.9 x 5.5 in.)	185 x 94 x 109 (7.3 x 3.7 x 4.3 in.)
Calibration Uncertainty (%)	±2	±5
Calibration Wavelength (µm)	10.6	
Cooling Method	Air-cooled	Fan-cooled
Cable Type	LM DB-25	
Cable Length (m)	1.8	
Part Number	1098346	1098440 (110VAC) 1098450 (220 VAC)

LM-100



*Threads per inch

LM-200



Beam Position Sensing Thermopile Sensors

100 mW to 150W

Models LM-150LS, LM-150FS, LM-20

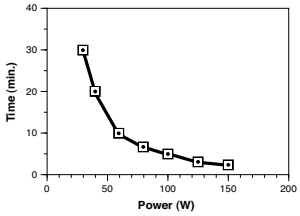
Features

- **Spectrally flat from 0.19 to 11 µm**
- **10 mW to 100 mW resolution**
- **19 mm apertures**
- **FC and SMA fiber connectors available (see page 51)**

The LM-20 is designed for embedded use and must be mounted on a heat sink. The LM-150 FS and LS sensors are designed for intermittent operation. Light shield is removable.

Use with LabMax (see page 10)

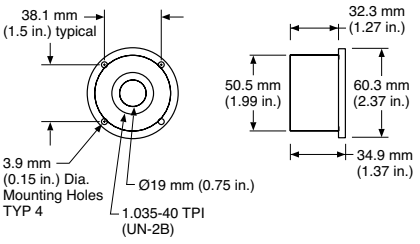
LM-150 FS and LS Power Duration



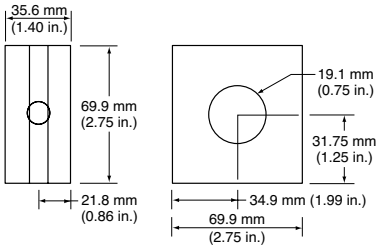
Device Specifications

Model	LM-20	LM-150 LS	LM-150 FS
Wavelength Range (µm)		0.25 to 10.6	
Power Range	100 mW to 20W	100 mW to 150W	100 mW to 150W
Long-Pulse Joules Range (J)		0.5 to 10	
Resolution (mW)		10	
Max. Power Density		6 kW/cm²	
Max. Energy Density		0.5 J/cm², 1064 nm, 10 ns	
Detector Coating		HTD	
Detector Diameter (mm)		19	
Dimensions (mm)	Ø60 x 32 (2.4 x 1.3 in.)	70 x 70 x 36 (2.8 x 2.8 x 1.4 in.)	Ø89 X 38 (3.5 x 1.4 in.)
Calibration Uncertainty (%)		±2	
Calibration Wavelength (µm)		10.6	
Cooling Method	Conductive-cooled	Air-cooled	
Cable Type		LM DB-25	
Cable Length (m)		1.8	
Part Number	1098456	1098452	1098394

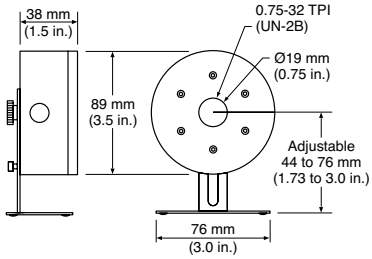
LM-20



LM-150 LS



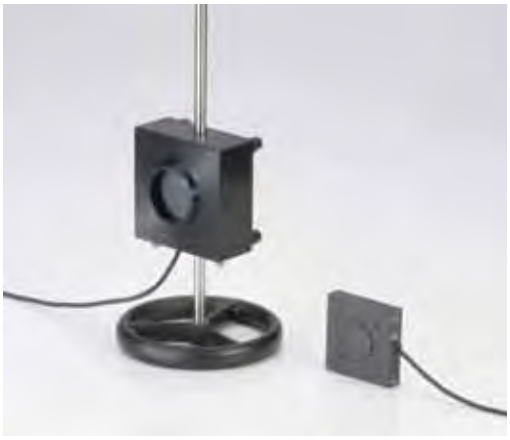
LM-150 FS



* Threads per inch

Beam Position Sensing Thermopile Sensors

100W to 5 kW



Models LM5000, BeamFinder

Features

- **Water-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **1W resolution**
- **35 mm to 55 mm apertures**

Use with LabMax
(see page 10)

These kilowatt thermopile sensors are water-cooled for measuring output over 100W and are excellent for use with CO_2 and Nd:YAG lasers.

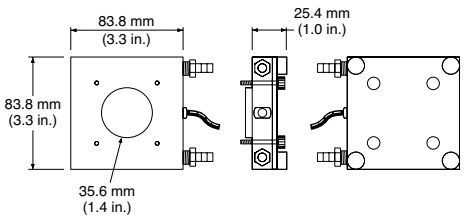
Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details). Water fittings are included.

Device Specifications

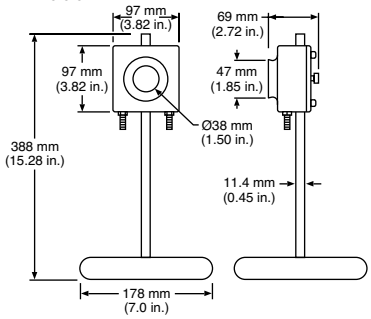
Model	BeamFinder	LM-1000	LM-2500	LM-5000
Wavelength Range (µm)	0.3 to 10.6	0.25 to 10.6		
Power Range (W)	100 to 1000		100 to 2500	100 to 5000
Resolution (W)	1			
Max. Power Density[1]	1 to 2.5 kW/cm²			
Max. Energy Density	0.5 J/cm², 1064 nm, 10 ns			
Detector Coating	H			
Active Area Diameter (mm)	35	38	55	
Dimensions (mm)	84 x 84 x 25.4 (3.3 x 3.3 x 1.0 in.)	97 x 97 x 69 (3.8 x 3.8 x 2.7 in.)	122 x 122 x 69 (4.8 x 4.8 x 2.7 in.)	
Calibration Uncertainty (%)	±5			
Calibration Wavelength (µm)	10.6			
Cooling Method	Water-cooled			
Cable Type	LM DB-25			
Cable Length (m)	6			
Part Number	1098427	1098409	1098437	1098421

[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

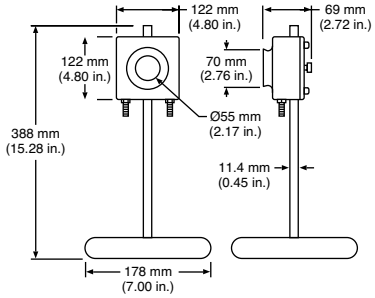
BeamFinder



LM-1000



LM-2500/LM-5000



High-Sensitivity Optical Power Sensors

10 nW to 50 mW, CW

Model OP-2/LM-2

Features

- Si, Ge photodiodes
- Spectral range: 250 nm to 1800 nm
- Fiber-optic connector (optional, see page 51)
- 1000:1 attenuator for measurement to 5W (optional, see page 50)

These high-sensitivity semiconductor sensors are ideal for CW laser measurements in the nW to low mW level. They typically saturate in the 10 to 50 mW level, depending upon the model. For linear operation up to a maximum of 5 Watts, an optional 1000:1 attenuator is used. Light shield is removable.

Accessories

1000:1 Attenuator

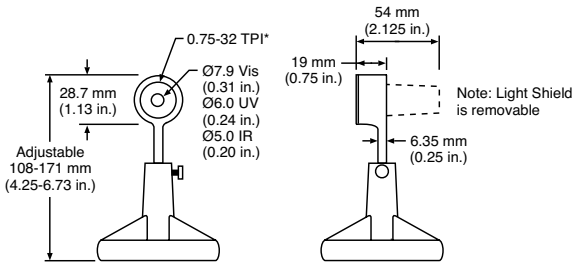
Fiber-Optic Connector Adapters

Device Specifications

Model	OP-2/LM-2 UV	OP-2/LM-2 VIS	OP-2/LM-2 IR
Detector Material	Silicon		Germanium
Wavelength Range (µm)	0.25 to 0.4	0.4 to 1.06	0.8 to 1.80/0.8 to 1.5[1]
Power Range	10 nW to 30 mW	10 nW to 30 mW[2]	10 nW to 10 mW
Resolution (nW)	1		
Active Area Diameter (mm)	6	7.9	5
Dimensions (mm)	Ø29 x 54 (1.1 x 2.1 in.)		
Calibration Uncertainty (%)	±8	±5	±4.5
Calibration Wavelength (nm)	Monochromator calibration across wavelength range		
Cooling Method	Air-cooled		
Connector Type	OP DB-25/LM DB-25		
Cable Length (m)	1.8		
Part Number			
OP-2	1098401	1098313	1098416
LM-2	1098390	1098298	1098342

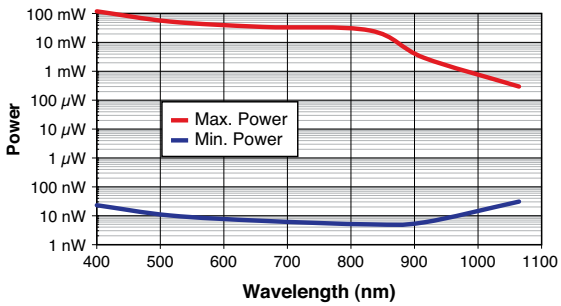
[1] OP-2 IR and LM-2 IR have different spectral ranges.
[2] Power range is wavelength dependent. See chart below.

OP-2 UV/OP-2 VIS/OP-2 IR
LM-2 UV/LM-2 VIS/LM-2 IR



* Threads Per Inch

Measurable Power vs. Wavelength
OP-2 VIS and LM-2 VIS



High-Sensitivity Thermopile Power Sensors

100 µW to 2W

Models PS19Q, PS19, PS10, PM3

Features

- **Thermally stabilized designs**
- **Spectrally flat from 0.3 µm to 11 µm**
- **10 µW resolution**
- **Fiber-optic connectors (optional, see page 51)**

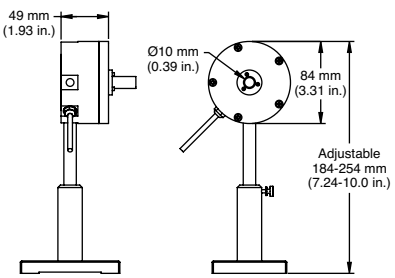
The PS10 and PS19 model sensors are thermally stabilized, amplified thermopile power sensors with a broad spectral response, high sensitivity, and a large active area. These sensors are ideal for measuring laser diodes, HeNe and HeCd lasers, and small ion lasers. The PS10 model includes a light tube mounted to the front of the housing, which minimizes the effects of background radiation. The light tube can be removed and replaced by FC or SMA fiber connectors (see Accessories - page 51). Where optimum stability is required, specify the PS10Q or PS19Q, which include a wedged quartz window for applications from 0.3 to 2.0 µm. The quartz window more effectively eliminates thermal background radiation and the effects of air currents.

Device Specifications

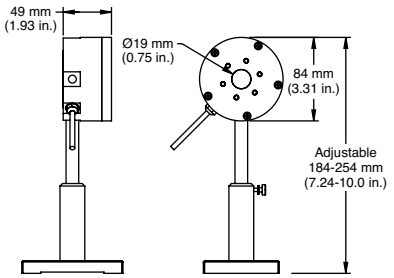
Model	PS10[2]	PS10Q	PS19	PS19Q	PM3[2]	PM3Q
Wavelength Range (µm)	0.19[3] to 11	0.3 to 2	0.19[3] to 11	0.3 to 2	0.19[3] to 11	0.3 to 2
Power Range	100 µW to 1W				500 µW to 2W	
Resolution (µW)	10				50	
Max. Thermal Drift[1]	±40 µW	±20 µW	±400 µW	±20 µW	±1 mW	±500 µW
Max. Avg. Power Density	0.5 kW/cm²					
Max. Pulse Energy Density	50 mJ/cm², 10 ns , 1064 nm					
Response Time (sec.)	2					
Detector Coating	Black					
Quartz Filter Window	No	Yes	No	Yes	No	Yes
Active Area Diameter (mm)	10		19		19	10
Dimensions (mm)	Ø84 x 49 (3.3 x 1.9 in.)				Ø63 x 36 (2.4 x 1.4 in.)	
Calibration Uncertainty (%)	±1					
Calibration Wavelength (nm)	514					
Cooling Method	Air-cooled					
Cable Type	PM DB-25					
Cable Length (m)	2					
Part Number	1098350	1098400	1098413	1098341	1098336	1098419

[1] Power stability over 30 minutes in a typical lab environment.
[2] Light tube supplied with PS10 and PM3 models only.
[3] 190nm to 300 nm operation restricted to <100 mW average power and <250W/cm² power density.

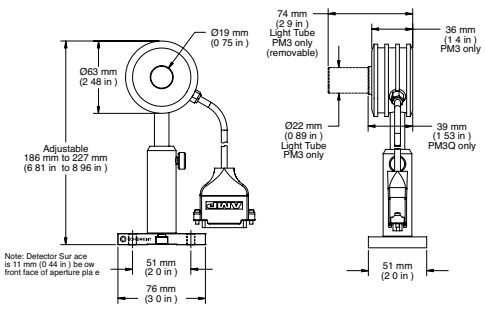
PS10/PS10Q



PS19/PS19Q



PM3/PM3Q



Air-Cooled Thermopile Sensors

10 mW to 30W

Models PM2, PM10, PM30

Features

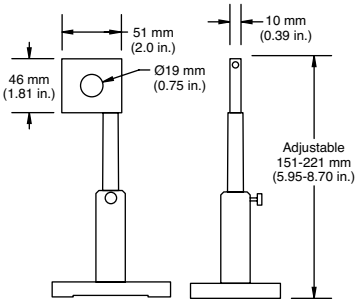
- **Convective air-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **1 to 10 mW resolution**
- **19 mm aperture**

These thermopile sensors are used to measure CW and pulsed lasers from 10 mW up to 30W average power output. These sensors are able to dissipate heat via convection cooling, which makes them convenient to use.

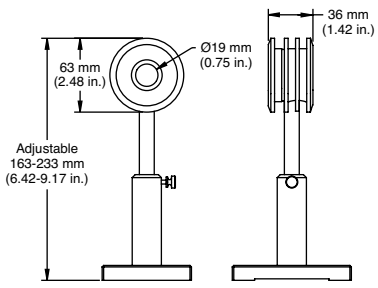
Device Specifications

Model	PM2	PM10	PM30
Wavelength Range (µm)		0.19 to 11	
Power Range	10 mW to 2W	10 mW to 10W	100 mW to 30W
Long-Pulse Joules Range (J)	0.5 to 2	0.5 to 10	0.5 to 50
Max. Intermittent Power (<5 min.)(W)	5	30	50
Resolution (mW)		1	10
Max. Power Density		26 kW/cm²	
Max. Energy Density		0.6 J/cm², 1064 nm, 10 ns	
Response Time (sec.)		2	
Detector Coating		Broadband	
Active Area Diameter (mm)		19	
Dimensions (mm)	46 x 51 x 10 (1.8 x 2.0 x 0.3 in.)	Ø63 x 36 (2.4 x 1.4 in.)	Ø101 x 56 (3.9 x 2.2 in.)
Calibration Uncertainty (%)		±1	
Calibration Wavelength (nm)		514	
Cooling Method		Air-cooled	
Cable Type		PM DB-25	
Cable Length (m)		2	
Part Number	1098329	1097901	1098314

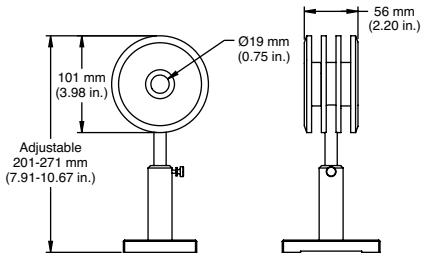
PM2



PM10



PM30



Air-Cooled Thermopile Sensors

300 mW to 150W

Models PM150-50, PM150, PM100-19C

Features

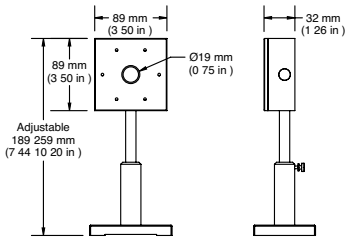
- Convective air-cooled
- Spectrally flat from 0.19 µm to 11 µm
- 30 mW resolution
- 19 mm and 50 mm apertures

Device Specifications

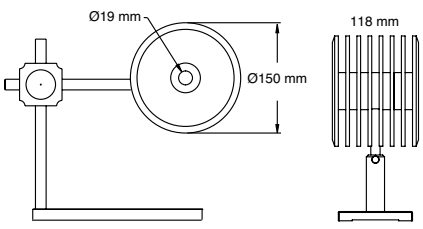
Model	PM100-19C[1]	PM150	PM150-50
Wavelength Range (µm)	0.19 to 11		
Power Range	300 mW to 100W	300 mW to 150W	
Long-Pulse Joules Range (J)	1 to 100	1 to 150	
Max. Intermittent Power (<5 min.)(W)	100	300	
Resolution (mW)	30		
Max. Power Density	26 kW/cm²		
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns		
Response Time (sec.)	2		5
Detector Coating	Broadband		
Active Area Diameter (mm)	19		50
Dimensions (mm)	89 x 89 x 32 (3.5 x 3.5 x 1.2 in.)	Ø150 x 118 (5.9 x 4.6 in.)	
Calibration Uncertainty (%)	±1		
Calibration Wavelength (nm)	514		
Cooling Method	Air-cooled		
Cable Type	PM DB-25		
Cable Length (m)	2		
Part Number	1098483	1098407	1098398

[1] This sensor is designed for intermittent use only.

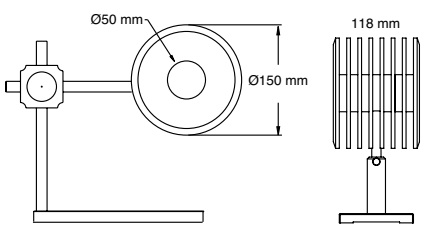
PM100-19C



PM150



PM150-50



Water-Cooled Thermopile Sensors

10 mW to 300W

Models PM300, PM150-50C, PM150-19C

Features

- **Water-cooled; but can be used air-cooled for short periods of time**
- **Spectrally flat from 0.19 µm to 11 µm**
- **1 mW to 100 mW resolution**
- **19 mm and 50 mm apertures**

These compact sensors are ideal in tight spaces, but must be water-cooled in order to achieve their full power specification during continuous operation. They can also be mounted to a heat sink or used standalone for intermittent use. Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details). Water fittings are included.

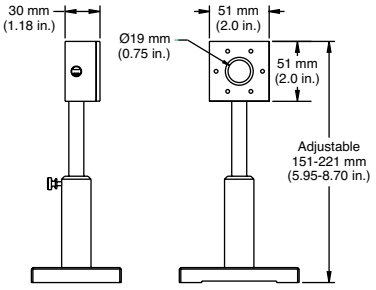
OEM versions of these sensors with passive and amplified outputs can be found on page 69.

Device Specifications

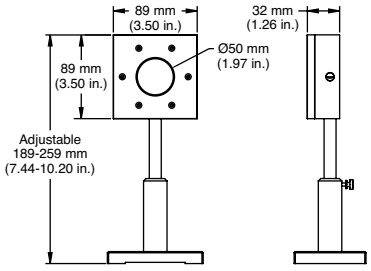
Model	PM10-19C	PM150-19C	PM150-50C	PM300
Wavelength Range (µm)	0.19 to 11			
Power Range (water-cooled)	10 mW to 10W	300 mW to 150W		1 W to 300W
Max. Intermittent Power (<5 min.) (W)	5W[1]	20W[1]	80W[1]	450W[2]
Long-Pulse Joules Range (J)	0.5 to 10	1 to 150		–
Resolution (mW)	1	30		100
Max. Power Density	26 kW/cm²			
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns			
Response Time (sec.)	2		5	
Detector Coating	Broadband			
Active Area Diameter (mm)	19		50	19
Dimensions (mm)	51 x 51 x 30 (2.0 x 2.0 x 1.1 in.)		89 x 89 x 32 (3.5 x 3.5 x 1.2 in.)	Ø76 x 56 (2.9 x 2.2 in.)
Calibration Uncertainty (%)	±1			
Calibration Wavelength (nm)	514			
Cooling Method	Water-cooled			
Cable Type	PM DB-25			
Cable Length (m)	2			
Part Number	1098397	1098444	1098412	1141474

[1] This intermittent power rating is for when the sensor is used without water-cooling.
[2] This intermittent power rating is for when the sensor is used with water-cooling.

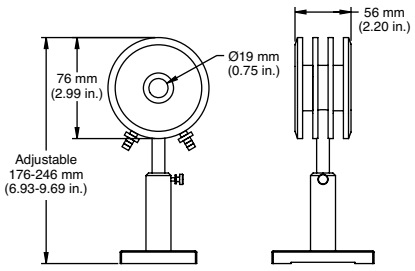
PM10-19C/PM150-19C



PM150-50C



PM300



Fan-Cooled Thermopile Sensors

1W to 300W

Models PM200F-50, PM300F-50

Features

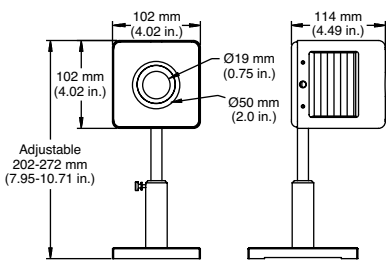
- **Fan-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **100 mW resolution**
- **19 mm and 50 mm apertures**

Fan-cooled sensors are an excellent choice for measuring high-power lasers when water-cooling is not possible. A compact power supply provides the 12 VDC required to power the fan.

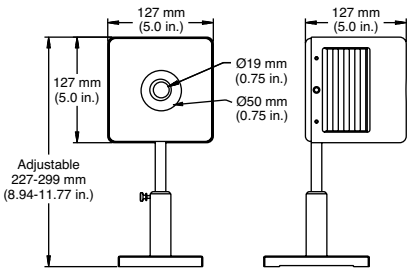
Device Specifications

Model	PM200F-19	PM200F-50	PM300F-19	PM300F-50
Wavelength Range (µm)	0.19 to 11			
Power Range (W)	1 to 200		1 to 300	
Long-Pulse Joules Range (J)	1 to 200		1 to 300	
Max. Intermittent Power (<5 min.)(W)	300		450	
Resolution (mW)	100			
Max. Power Density	26 kW/cm²			
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns			
Response Time (sec.)	2	5	2	5
Detector Coating	Broadband			
Active Area Diameter (mm)	19	50	19	50
Dimensions (mm)	102 x 102 x 114 (4.0 x 4.0 x 4.4 in.)		127 x 127 x 127 (5 x 5 x 5 in.)	
Calibration Uncertainty (%)	±1			
Calibration Wavelength (nm)	514			
Cooling Method	Fan-cooled			
Cable Type	PM DB-25			
Cable Length (m)	2			
Part Number	1098480	1098472	1098509	1098417

PM200F-19/PM200F-50



PM300F-19/PM300F-50



Water-Cooled Thermopile Sensors

100W to 5 kW

Model PM1K

Features

- **Water-cooled**
- **Spectrally flat from 0.19 µm to 11 µm**
- **1W resolution**
- **50 mm apertures**

These water-cooled sensors are used to measure lasers over 300W average power output. They are excellent choices for measuring CO_2 and Nd:YAG lasers. Larger-area versions are available on the next page.

Tap or distilled cooling water is recommended with these sensors – DI water can not be used. Flow rates are power dependent and range from 0.5 to 4 gallons per minute; pressure depends upon flow rate and ranges from 3 to 40 PSI (visit product pages at www.Coherent.com/LMC for more technical details). Water fittings are included.

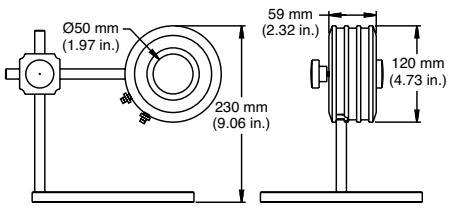
Device Specifications

Model	PM1K	PM3K	PM5K
Wavelength Range (µm)		0.19 to 11	
Power Range (W)	100 to 1000	100 to 3000	100 to 5000
Max. Intermittent Power (<5 min.)(W)[1]	3000	5000	10000
Resolution (W)		1	
Max. Power Density[2]		1 to 10 kW/cm²	
Max. Energy Density		0.6 J/cm², 1064 nm, 10 ns	
Response Time (sec.)		30	
Detector Coating		Broadband	
Active Area Diameter (mm)		50	
Dimensions (mm)		Ø120 x 59 (4.7 x 2.3 in.)	
Calibration Uncertainty (%)		±5	
Calibration Wavelength (nm)		1064	
Cooling Method		Water-cooled	
Cable Type		PM DB-25	
Cable Length (m)		2	
Part Number	1098392	1098462	1098454

[1] Intermittent power levels may be sustainable for longer than 5 minutes when used with lasers with large diameter, non-Gaussian beam profiles. Monitor closely for coating damage if used longer than five minutes at higher powers.

[2] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

PM1K/PM3K/PM5K



Large-Area High-Power Water-Cooled Thermopile Sensors

10 mW to 5 kW

Models PM5K-200, PM3K-100

Features

- **Water-cooled**
- **100 mm and 200 mm apertures**
- **Spectrally flat from 0.19 µm to 11 µm**

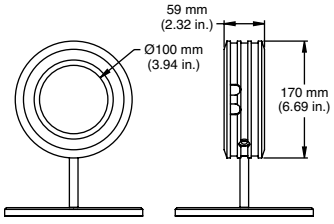
These large-area, water-cooled thermopiles are designed to measure large laser diode stacks and arrays, and other high-power divergent sources. Water fittings are included

Device Specifications

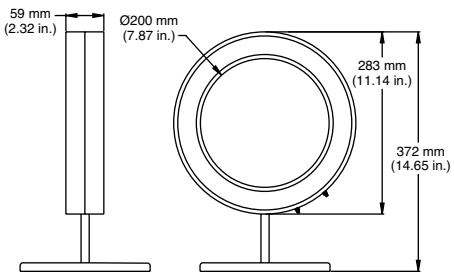
Model	PM1K-100	PM3K-100	PM5K-100	PM5K-200
Wavelength Range (µm)	0.19 to 11			
Power Range (W)	100 to 1000	100 to 3000	100 to 5000	100 to 5000
Max. Intermittent Power (<5 min.)(W)	1500	4000	7500	7500
Resolution (W)	1			
Max. Power Density[1]	1 to 10 kW/cm²			
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns			
Response Time (sec.)	45			
Detector Coating[1]	Broadband			
Detector Diameter (mm)	100			200
Dimensions (mm)	Ø170 X 59 (6.6 x 2.3 in.)			Ø283 x 59 (11.1 x 2.3 in.)
Calibration Uncertainty (%)	±5			
Calibration Wavelength (nm)	1064			
Cooling Method	Water-cooled			
Cable Type	PM DB-25			
Cable Length (m)	2			
Part Number	1098490	1098506	1098461	1098505

[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

PM1K-100/PM3K-100/PM5K-100



PM5K-200



High-Peak-Power Thermopile Sensors

10 mW to 30W

Models PM30V1, PM10V1

Features

- **Volume absorber**
- **2 J/cm² at 1064 nm**

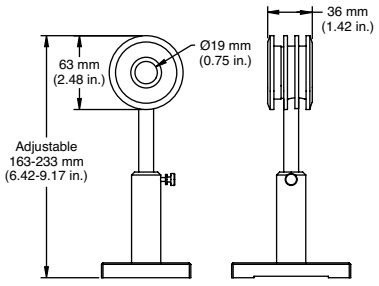
These sensors are designed for use with high-peak-power, low repetition rate, Q-switched Nd:YAG lasers. A volume-absorbing substrate mounted in front of the detector absorbs the bulk of the laser energy rather than all of the energy striking the front surface of the detector element. This results in a much higher damage threshold, approaching 2 J/cm², at relatively low repetition rates of approximately 10 pps. For damage thresholds approaching 5 J/cm² the PM30V1Q uses an additional quartz diffuser to help scatter the beam before it hits the absorber surface. A removable front aperture allows easy replacement of the volume-absorbing substrate should it be damaged (replacement absorbers may be ordered using part number 0011-8935, PMV1-KIT).

Device Specifications

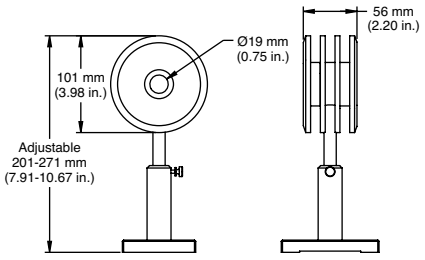
Model	PM10V1	PM30V1
Wavelength Range (µm)	0.25 to 3	
Power Range	10 mW to 10W	100 mW to 30W
Max. Intermittent Power (<5 min.)(W)	15	50
Resolution (mW)	1	10
Max. Power Density	50 W/cm²	
Max. Energy Density	2 J/cm², 1064 nm, 10 ns	
Response Time (sec.)	3	
Detector Coating	Volume Absorbing	
Active Area Diameter (mm)	19	
Dimensions (mm)	Ø63 x 36 (2.4 x 1.4 in.)	Ø101 x 56 (3.9 x 2.2 in.)
Calibration Uncertainty (%)	±1	
Calibration Wavelength (nm)	514	
Cooling Method	Air-cooled	
Cable Type	PM DB-25	
Cable Length (m)	2	
Part Number[1]	1098338	1098429

[1] Diffuser transmission calibrated at 266 nm, 355 nm, 532 nm and 1064 nm.

PM10V1



PM30V1/PM30V1Q



Thermopile Sensors with UV Coating

10 mW to 30W

Model PM2X, PM10X, PM30X

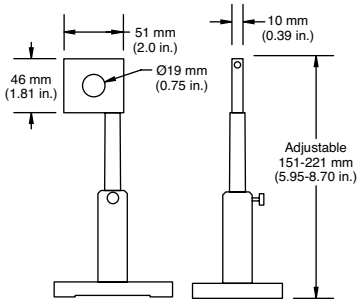
Features

- **UV coating is optimized for DUV**
- **Spectral range: 0.15 µm to 1 µm**
- **1 mW to 10 mW resolution**
- **19 mm apertures**

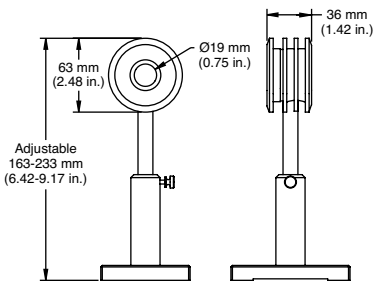
The following sensors are similar to models shown on previous pages, except they incorporate a UV coating that is optimized for use at ultraviolet wavelengths. Spectral compensation allows the sensors to be used from 157 nm to 1064 nm.

Device Specifications	Model	PM2X	PM10X	PM30X
	Wavelength Range (µm)		0.15 to 1	
	Power Range	10 mW to 2W	10 mW to 10W	100 mW to 30W
	Long-Pulse Joules Range (J)	0.5 to 2	0.5 to 10	0.5 to 50
	Max. Intermittent Power (<5 min.) (W)	3	30	50
	Resolution (mW)	1	1	10
	Max. Power Density		26 kW/cm²	
	Max. Energy Density		0.6 J/cm², 1064 nm, 10 ns	
	Response Time (sec.)		2	
	Detector Coating		UV	
	Active Area Diameter (mm)		19	
	Dimensions (mm)	46 x 51 x 10 (1.8 x 2.0 x 0.3 in.)	Ø63 x 36 (2.4 x 1.4 in.)	Ø101 x 56 (3.9 x 2.2 in.)
	Calibration Uncertainty (%)		±1	
	Calibration Wavelength (nm)		514	
	Cooling Method		Air-cooled	
	Cable Type		PM DB-25	
	Cable Length (m)		2	
	Part Number	1098457	1098423	1098498

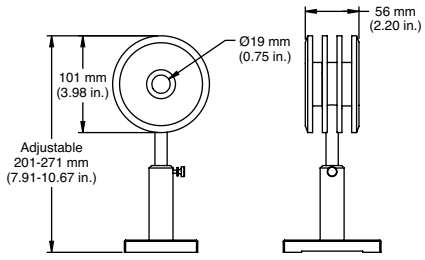
PM2X



PM10x



PM30x



Thermopile Sensors with UV Coating

300 mW to 150W

Model PM150X, PM150-50XC

Features

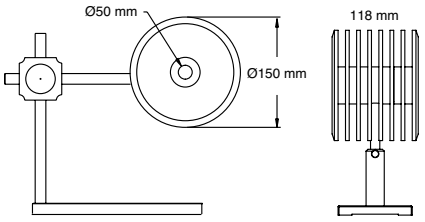
- UV coating is optimized for DUV
- Spectral Range: 0.15 µm to 1 µm
- 30 mW resolution
- 50 mm apertures

Device Specifications

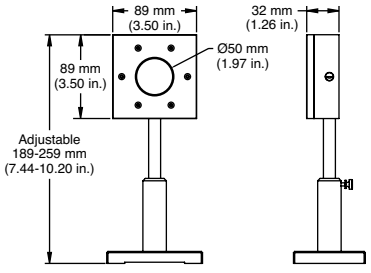
Model	PM150X	PM150-50XC
Wavelength Range (µm)	0.15 to 1	
Power Range	300 mW to 150W	
Long-Pulse Joules Range (J)	1 to 150	
Max. Intermittent Power (<5 min.)(W)	300	80 (air-cooled)
Resolution (mW)	30	
Max. Power Density	26 kW/cm²	
Max. Energy Density	0.6 J/cm2, 1064 nm, 10 ns	
Response Time (sec.)	5	
Detector Coating	UV	
Active Area Diameter (mm)	50	
Dimensions (mm)	150 x 118 (5.9 x 4.6 in.)	89 x 89 x 32 (3.5 x 3.5 x 1.2 in.)
Calibration Uncertainty (%)	±1	
Calibration Wavelength (nm)	514	
Cooling Method	Air-cooled	Water-cooled
Cable Type	PM DB-25	
Cable Length (m)	2	
Part Number[1]	1098455	1098443

[1] Water fittings are included with PM150-50XC.

PM150X



PM150-50XC



Thermopile Sensors with UV Coating

1W to 1 kW

Model PM200F-50X, PM300F-50X, PM1KX

Features

- UV coating is optimized for DUV
- Spectral Range: 0.15 µm to 1 µm
- 100 mW to 1W resolution
- 50 mm apertures

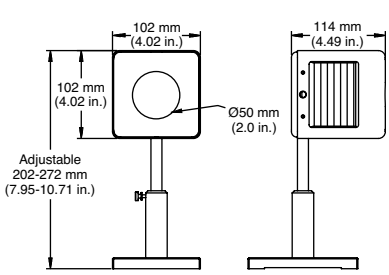
Device Specifications

Model	PM200F-50X	PM300F-50X	PM1KX
Wavelength Range (µm)	0.15 to 1		0.15 to 1
Power Range (W)	1 to 200	1 to 300	100 to 1000
Long-Pulse Joules Range (J)	1 to 200	1 to 300	–
Max. Intermittent Power (<5 min.)(W)	300	450	1500
Resolution (mW)	100	100	1000
Max. Power Density	26 kW/cm²		1 to 10 kW/cm² [1]
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns		0.6 J/cm², 1064 nm, 10 ns
Response Time (sec.)	5		30
Detector Coating	UV		UV
Active Area Diameter (mm)	50		50
Dimensions (mm)	102 X 102 X 114 (4.0 X 4.0 X 4.4 in.)	127 X 127 X 127 (5 X 5 X 5 in.)	Ø120 X 59 (4.7 X 2.3 in.)
Calibration Uncertainty (%)	±1		±5
Calibration Wavelength (nm)	514		1064
Cooling Method	Fan-cooled		Water-cooled
Cable Type	PM DB-25		PM DB-25
Cable Length (m)	2		2
Part Number[2]	1113493	1098481	1115484

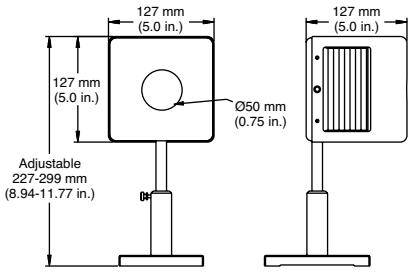
[1] The damage resistance of the coating is dependent upon the beam size and profile, the average power level, and the water flow rate. Contact Coherent or your local representative for details related to your application.

[2] Water fittings are included with PM1KX.

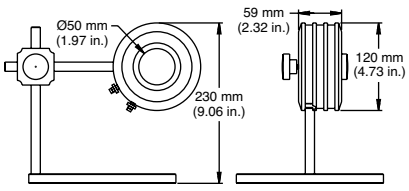
PM200F-50X



PM300F-50X



PM1KX



Power Sensor Accessories

Thermal SmartSensor Adapter

Thermal SmartSensor Adapter

The Thermal SmartSensor Adapter converts LM-model position-sensing thermopiles and LM-2 optical sensors for use with FieldMaxII, FieldMate and EPM2000 meters.

Designed for use with multiple sensors, this adapter can read the sensor EEPROM contents and program itself when powered up via the meter connection.

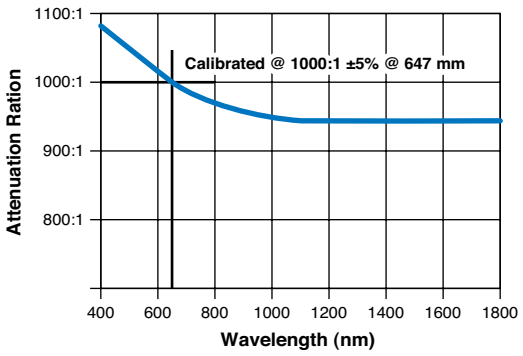
Note: Beam position information is not available when using these meters.

Part Number	Description
1056827	Thermal SmartSensor Adapter

1000:1 Attenuator

1000:1 Attenuator

This attenuator is used with OP-2 VIS, LM-2 VIS, OP-2 IR and LM-2 IR sensors to allow operation up to 5W in the visible and 3W in the infrared regions. The attenuator threads into the sensor in place of the light shield to provide from 1100:1 to 950:1 attenuation. Each attenuator is calibrated for 1000:1 ±5% at 647 nm and is supplied with a calibration certificate. The useful spectral range is 400 to 1800 nm.



Part Number	Description
1098318	1000:1 Attenuator for OP-2 and LM-2 Sensors

SMA and FC Adapters

Power Sensor Accessories

Fiber-Optic Connector Adapters

SMA and FC Adapters

The following fiber-optic adapters can be mounted directly onto the 3/4-32 threads on the front of LM-2, OP-2, LM-3, LM-10, and LM-150FS sensors. These fiber adapters can also be used with our 1.035-40M adapter ring to fit on the LM-20, LM-45, LM-100, LM-150 LS, and LM-200 sensors.

Part Number	Description	Sensors
1098589	SMA-Type Connector	LM-2, OP-2, LM-3, LM-10, LM-150 FS
1098339	FC/PC-Type Connector	LM-2, OP-2, LM-3, LM-10, LM-150 FS
33-9432-000	1.035-40M Adapter Ring	LM-20, LM-45, LM-100, LM-150 LS, LM-200

SMA and FC Adapters

The following fiber adapters can be mounted onto the front of the PS10 sensor in place of the removable light tube.

Part Number	Description	Sensors
0012-3860	PS-SMA-Type Connector	PS10
0012-3863	PS-FC-Type Connector	PS10

EnergyMax - Laser Energy Sensors

Introduction and Selection Charts

EnergyMax Sensors

Features

- **Superior damage resistance**
- **High repetition rate operation**
- **Large dynamic range gives each sensor broad coverage**
- **Low noise and excellent linearity for greater accuracy**
- **Large active area**

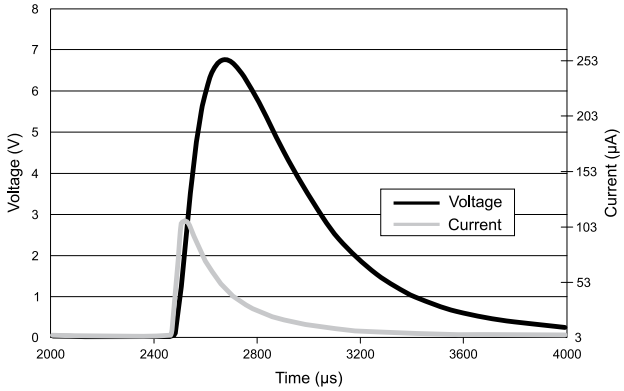
Coherent EnergyMax sensors enable laser pulse energy measurement over a broad range of wavelengths, repetition rates, pulse energies and beam diameters. With their unique combination of superior performance and user-friendly convenience, EnergyMax sensors are your best choice no matter what your particular laser energy measurement need. EnergyMax sensors are highly linear in terms of repetition rate, laser pulse width, and measured energy. They are also accurate across a broad range of wavelengths due to onboard wavelength compensation. In addition, automatic temperature compensation accounts for changes in ambient temperature, as well as for heat generated by absorption of the laser energy. Temperature compensation also enables the use of user-installable heat sinks for even higher average power handling capabilities. Coherent EnergyMax sensors are the most linear and accurate on the market.

Fundamental Principles

Unlike all other thermal detectors, pyroelectrics measure the rate of change of the detector temperature, rather than the temperature value itself. As a result, the response speed of the pyroelectric is usually limited by its electrical circuit design and the thermal resistance of the absorptive coating. In contrast, other thermal detectors (such as thermopiles and bolometers) are limited by slower thermal response speeds, typically on the order of seconds. Pyroelectrics respond only to changing radiation that is chopped, pulsed, or otherwise modulated, so they ignore steady background radiation that is not changing with time. Their combination of wide uniform spectral response, sensitivity, and high speed makes pyroelectrics ideal choices for a vast number of electro-optic applications.

The EnergyMax sensor line uses a pyroelectric element to measure the energy in a laser pulse. It does this by producing a large electrical charge for a small change in temperature. The active sensor circuit takes the current from the sensor element and converts it to a voltage that the instrument can measure.

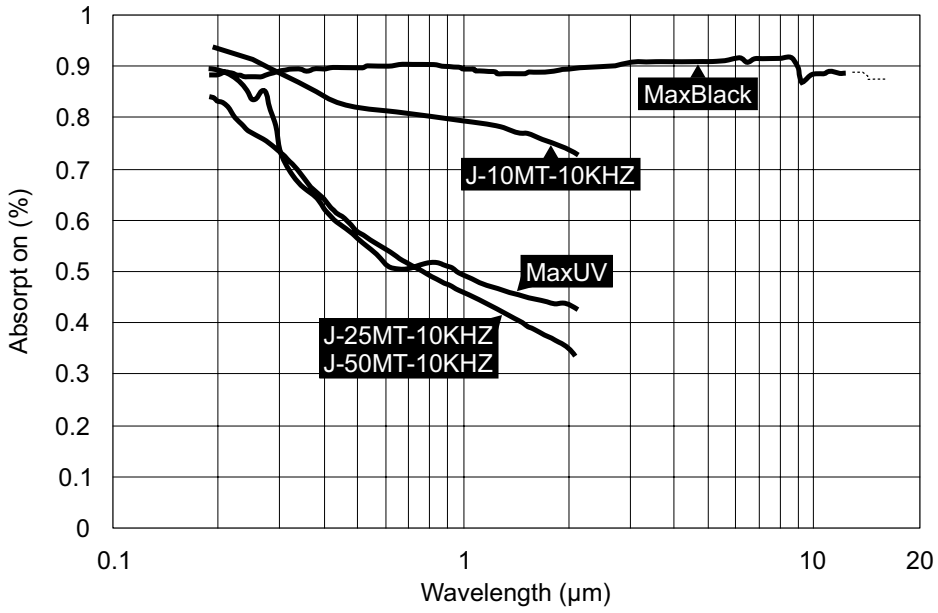
The figure below shows the relationship between the current response of the pyroelectric element and the output voltage of the sensor circuit. The relationship between the current response and the output voltage response is fixed so that the calibrated peak voltage of the output is the integrated energy of the laser pulse. Refer to the User Manual for information on Quantum EnergyMax sensors.

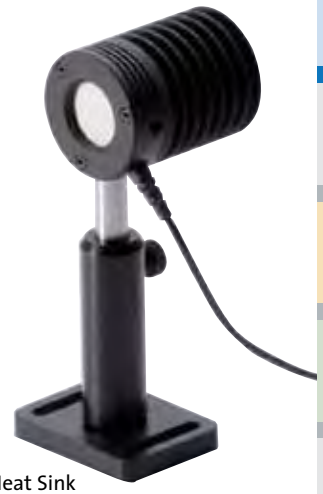


EnergyMax - Laser Energy Sensors

Introduction and Selection Charts

All pyroelectric EnergyMax sensors incorporate a diffuse coating to minimize specular reflections and eliminate spurious beams that can re-enter the laser cavity. In addition, all EnergyMax sensors include onboard electronics that contain built-in wavelength compensation factors. When using the sensor with a meter such as LabMax or FieldMaxII, enter the wavelength of the laser being measured into the meter and this will automatically compensate for the sensor output. The chart below plots the typical absorption percentage of each coating.





J-25MT-10KHZ
with Medium Heat Sink

Meter Compatibility Chart		LabMax-TOP	FieldMaxII-TOP & -P	EPM2000
	All J-10MB-, J-25MB-, J-50MB-, J-25MUV-, J-50MUV- EnergyMax Models	•	•	•
	J-10MT-10KHZ, J-25MT-10KHz, J-50MT-10KHZ EnergyMax Models	•		•
	J-10SI- and J-10GE Quantum EnegyMax Models	•		•

Explanation of Part Numbers

EnergyMax part numbers are "Smart" part numbers that have the following meaning:

J – **Active Area Diameter** – **Coating Type** – **Descriptive Suffix**

Active Area Diameter	Coating Type	Descriptive Suffix
10, 25, or 50 mm	MT for Diffuse Metallic MB for MaxBlack MUV for MaxUV	LE for Low Energy HE for High Energy 10 KHZ for Max. Rep. Rate 193 and 248 Calibrated Wavelength

J: Represents an energy sensor

Example: J-10MB-LE is an energy sensor with a 10 mm active area diameter MaxBlack coating for low energy measurements

EnergyMax - Laser Energy Sensors

Applying Wavelength Compensation Accuracy

Overall measurement accuracy is a combination of calibration uncertainty (found in the sensor specification tables) and the wavelength compensation accuracy (found in the "Wavelength Compensation Accuracy" table, below).

The combined accuracy is based upon practices outlined in the National Institute of Standards Guidelines for Evaluating and Expressing Uncertainty (NIST Technical Note 1297, 1994 Edition). The combined accuracy of the measurement is calculated by using the law of propagation of uncertainty using the "root-sum-of-square" (square root of the sum of squares), sometimes described as "summing in quadrature" where:

$$\text{Measurement Accuracy} = \sqrt{U^2 + W^2}$$

where U = 'Percent Calibration Uncertainty' and W = 'Wavelength Accuracy'

Example 1

J-10SI-HE used at 355 nm

U = 3%
W = 5%

$$\text{Measurement Accuracy} = \sqrt{3^2 + 5^2} = \sqrt{9 + 25} = 5.8\%$$

Example 2

J-10MB-LE used at 532 nm

U = 2%
W = 2%

$$\text{Measurement Accuracy} = \sqrt{2^2 + 2^2} = \sqrt{4 + 4} = 2.8\%$$

Wavelength Compensation Accuracy

Model	Wavelength Compensation Accuracy (%) (for wavelengths other than the calibration wavelength)	Calibration Wavelength (nm)
All Multipurpose Sensors (MaxBlack Coating)	±2	1064
All High Repetition Rate Sensors (Diffuse Metallic Coating)	±3	1064
J-50MB-YAG	±2	1064
J-50MB-IR	±3	1064, 2940
J-25MB-IR	±4	1064
J-25MUV-193	±3	193
J-25MUV-248	±3	248
J-50MUV-193	±4	193
J-50MUV-248	±4	248
J-10SI-LE	±5	532
J-10SI-HE	±5	532
J-10GE	±5	1064

EnergyMax - Laser Energy Sensors

Introduction and Selection Charts

The next table summarizes the maximum average power rating for each sensor. These power levels are achieved by combining active temperature compensation circuitry and enhanced thermal management techniques. Maximum average power is wavelength dependent because absorption changes with wavelength. Reference the spectral absorption chart on the previous page for use at wavelengths other than those listed in the table below. Maximum average power is inversely proportional to the spectral absorption.

The 25 mm and 50 mm aperture sensors can accept optional heat sinks that users can install by mounting them on the back of the sensor. The heat sinks expand the average power handling capability as outlined below. See the Accessories section on page 64 for more information about heat sinks.

EnergyMax Average Power Capabilities[1]

Model	Wavelength[5] (nm)	Heat Sink			
		None	Small	Medium	Large
J-50MB-HE[2] & -LE[2]	1064	10W	–	–	24W
J-25MB-HE[3] & -LE[3]	1064	5W	10W	15W	–
J-10MB-HE[4] & -LE[4]	1064	4W	–	–	–
J-50MT-10KHZ[2]	1064	20W	–	–	49W
J-25MT-10KHZ[3]	1064	10W	20W	31W	–
J-10MT-10KHZ[4]	1064	1W	–	–	–
J-50MB-YAG[2]	1064	20W	–	–	48W
J-50MB-IR	1064, 2940	15W	–	–	–
J-25MB-IR[3]	1064	20W	41W	62W	–
J-50MUV-248[2] w/o Diffuser	248	10W	–	–	25W
J-50MUV-248[2] w/Diffuser	248	15W	–	–	36W
J-50MUV-193[2] w/o Diffuser	193	10W	–	–	30W
J-50MUV-193[2] w/Diffuser	193	18W	–	–	43W
J-25MUV-248[3]	248	5W	10W	16W	–
J-25MUV-193[3]	193	5W	10W	15W	–

[1] Not applicable for Quantum EnergyMax sensors.
[2] 50 mm EnergyMax sensors are compatible with the large heat sink.
[3] 25 mm EnergyMax sensors are compatible with small and medium heat sinks.
[4] 10 mm EnergyMax sensors do not have a heat sink available.
[5] Average power ratings are based upon testing at the listed wavelength.

Use the following chart to identify sensors that operate within the energy range you intend to measure. Selection charts on the following pages of this guide will help you select more exactly the best sensor for your application. See page 63 for typical dynamic range curves of Quantum EnergyMax Sensors.

EnergyMax Energy Range Capabilities

Model	Energy Range	Wide Dynamic Range for All EnergyMax Sensor Categories: 100 nJ · 1 µJ · 10 µJ · 100 µJ · 1 mJ · 10 mJ · 100 mJ · 1J · 10J
J-50MB-HE	1 mJ to 2J	
J-50MB-LE	250 µJ to 500 mJ	
J-25MB-HE	500 µJ to 1J	
J-25MB-LE	25 µJ to 50 mJ	
J-10MB-HE	10 µJ to 20 mJ	
J-10MB-LE	300 nJ to 600 µJ	
J-50MT-10KHZ	500 µJ to 1J	
J-25MT-10KHZ	50 µJ to 100 mJ	
J-10MT-10KHZ	100 nJ to 200 µJ	
J-50MB-YAG	1.5 mJ to 3J	
J-50MB-IR	1 mJ to 3J	
J-25MB-IR	1.5 mJ to 3J	
J-50MUV-248	500 µJ to 1J	
J-50MUV-193	125 µJ to 250 mJ	
J-25MUV-248	125 µJ to 250 mJ	
J-25MUV-193	50 µJ to 100 mJ	

EnergyMax - Laser Energy Sensors

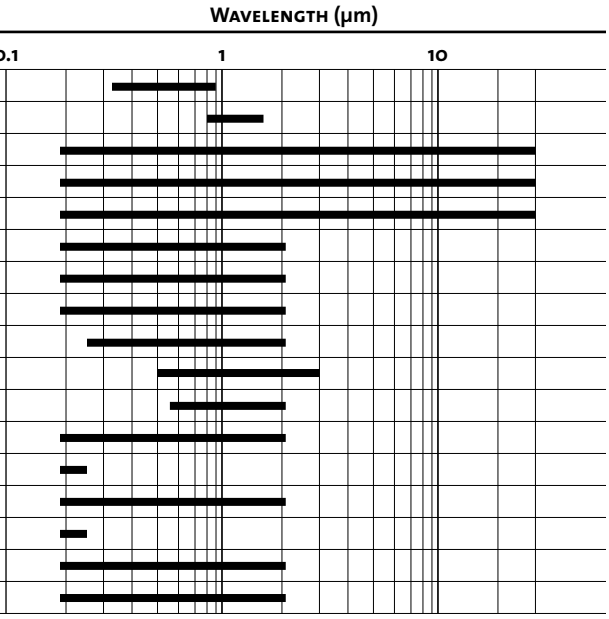
Introduction and Selection Charts

The next selection chart shows the range of wavelengths that can be measured with each sensor. This characteristic is coating dependent, so sensors with diffusers may have a narrower spectral range than similar sensors without diffusers.

The spectral compensation of each sensor is unique to that serial number, and is based upon spectral scans performed on each sensor disk (and on each optic if the sensor has a diffuser). The spectral compensation provides greater measurement accuracy for wavelengths that differ from the optical calibration wavelength.

EnergyMax Wavelength Capabilities

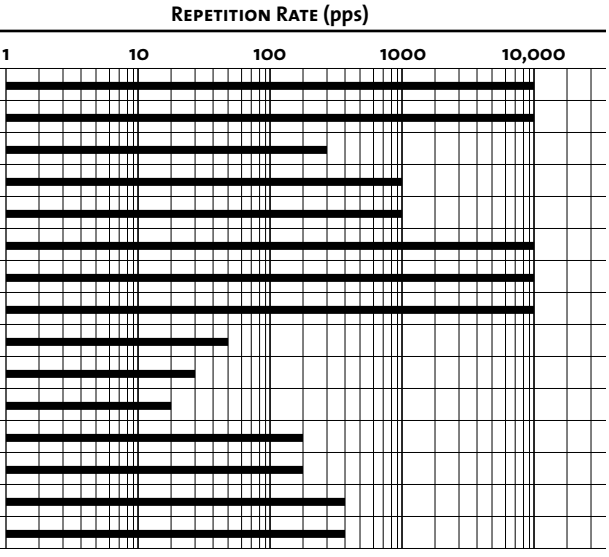
Model	Wavelength (µm)
J-10SI-HE & -LE	0.325 to 0.9
J-10GE	0.8 to 1.7
J-50MB-HE & -LE	0.19 to 12.0
J-25MB-HE & -LE	0.19 to 12.0
J-10MB-HE & -LE	0.19 to 12.0
J-50MT-10KHZ	0.19 to 2.1
J-25MT-10KHZ	0.19 to 2.1
J-10MT-10KHZ	0.19 to 2.1
J-50MB-YAG	0.266 to 2.1
J-50MB-IR	0.5 to 3.0
J-25MB-IR	0.532 to 2.1
J-50MUV-248 w/o Diffuser	0.19 to 2.1
J-50MUV-248 w/Diffuser	0.19 to 0.266
J-50MUV-193 w/o Diffuser	0.19 to 2.1
J-50MUV-193 w/Diffuser	0.19 to 0.266
J-25MUV-248	0.19 to 2.1
J-25MUV-193	0.19 to 2.1



EnergyMax sensors are based upon pyroelectric technology and can therefore measure lasers at high repetition rates. The maximum repetition rate is primarily dependent upon the thermal resistance of the coating and the maximum pulse width the sensor is designed to measure. Refer to the summary table on page 8 for maximum laser pulse width limitations.

EnergyMax Repetition Rate Capabilities

Model	Rep. Rate (pps)
J-10SI-HE & -LE	up to 10,000
J-10GE	up to 10,000
J-50MB-HE & -LE	up to 300
J-25MB-HE & -LE	up to 1000
J-10MB-HE & -LE	up to 1000
J-50MT-10KHZ	up to 10,000
J-25MT-10KHZ	up to 10,000
J-10MT-10KHZ	up to 10,000
J-50MB-YAG	up to 50
J-50MB-IR	up to 30
J-25MB-IR	up to 20
J-50MUV-248	up to 200
J-50MUV-193	up to 200
J-25MUV-248	up to 400
J-25MUV-193	up to 400



EnergyMax - Laser Energy Sensors

Energy Sensor Summary Specifications

Before using a sensor, it is important to ensure that the laser beam will not damage the sensor coating. The damage threshold is also wavelength dependent, and maximum energy density thresholds are listed for common laser wavelengths in the table below. At other wavelengths it is safe to interpolate between the listed values.

EnergyMax Damage Threshold Capabilities[1]

	Damage Threshold (mJ/cm²)					
Model	**193 nm**	**248 nm**	**266 nm**	**355 nm**	**532 nm**	**1064 nm**
J-50MB-HE	40	170	170	140	250	500
J-50MB-LE	40	170	170	140	250	500
J-25MB-HE	40	170	170	140	250	500
J-25MB-LE	40	170	170	140	250	500
J-10MB-HE	40	170	170	140	250	500
J-10MB-LE	40	170	170	140	250	500
J-50MT-10KHZ	150	200	200	390	500	500
J-25MT-10KHZ	150	200	200	390	500	500
J-10MT-10KHZ	40	40	40	50	50	50
J-50MB-YAG	–	–	1000	750	2800	14,000
J-25MB-IR	–	–	–	–	1500	5000
J-50MUV-248 w/o Diffuser	200	260	260	300	375	375
J-50MUV-248 w/Diffuser	400	520	520	–	–	–
J-50MUV-193 w/o Diffuser	200	260	260	300	375	375
J-50MUV-193 w/Diffuser	400	520	520	–	–	–
J-25MUV-248	200	260	260	300	375	375
J-25MUV-193	200	260	260	300	375	375

[1] Not applicable for Quantum EnergyMax sensors.

The table below shows the key specifications for each sensor. Additional specifications can be found on pages 58 to 62.

Part Number	Description	Wavelength Range (µm)	Min. Energy	Max. Energy	Max. Average Power (W)				Max. Rep. Rate (pps)	Max. Pulse Width (µs)	Active Area Dia. (mm)	Detector Coating	Diffuser	Calibration Wavelength
					No H.S.[1]	Small H.S.	Med. H.S.	Large H.S.						
1110573	J-50MB-HE	0.19 to 12	1 mJ	2J	10	–	–	24	300	57	50	MaxBlack	None	1064
1110576	J-50MB-LE	0.19 to 12	250 µJ	500 mJ	10	–	–	24	300	57	50	MaxBlack	None	1064
1110746	J-25MB-HE	0.19 to 12	500 µJ	1J	5	10	15	–	1000	17	25	MaxBlack	None	1064
1110743	J-25MB-LE	0.19 to 12	25 µJ	50 mJ	5	10	15	–	1000	17	25	MaxBlack	None	1064
1110843	J-10MB-HE	0.19 to 12	10 µJ	20 mJ	4	–	–	–	1000	17	10	MaxBlack	None	1064
1110855	J-10MB-LE	0.19 to 12	300 nJ	600 µJ	4	–	–	–	1000	17	10	MaxBlack	None	1064
1110574	J-50MT-10KHZ	0.19 to 2.1	500 µJ	1J	20	–	–	49	10000	1.7	50	Diff. Met.[2]	None	1064
1110747	J-25MT-10KHZ	0.19 to 2.1	50 µJ	100 mJ	10	20	31	–	10000	1.7	25	Diff. Met.	None	1064
1110856	J-10MT-10KHZ	0.19 to 2.1	100 nJ	200 µJ	1	–	–	–	10000	1.7	10	Diff. Met.	None	1064
1110744	J-50MB-YAG	0.266 to 2.1	1.5 mJ	3J	20	–	–	48	50	340	50	MaxBlack	YAG	1064
1155722	J-50MB-IR	0.5 to 3	1 mJ	3J	15W	–	–	–	30	1000	50	MaxBlack	IR	1064, 2940
1110577	J-25MB-IR	0.532 to 2.1	1.5 mJ	3J	20	41	62	–	20	860	25	MaxBlack	IR	1064
1146243	J-50MUV-248 w/o Diffuser	0.19 to 2.1	500 µJ	1J	10	–	–	25	200	86	50	MaxUV	None	248
1110572	J-50MUV-248 w/Diffuser	0.19 to 0.266	500 µJ	1J	15	–	–	36	200	86	50	MaxUV	DUV	248
1146237	J-50MUV-193 w/o Diffuser	0.19 to 2.1	125 µJ	250 mJ	10	–	–	30	200	86	50	MaxUV	None	193
1110575	J-50MUV-193 w/Diffuser	0.19 to 0.266	125 µJ	250 mJ	18	–	–	43	200	86	50	MaxUV	DUV	193
1110745	J-25MUV-248	0.19 to 2.1	125 µJ	250 mJ	5	10	16	–	400	43	25	MaxUV	None	248
1110741	J-25MUV-193	0.19 to 2.1	50 µJ	100 mJ	5	10	15	–	400	43	25	MaxUV	None	193
1150146	J-10SI-HE	0.325 to 0.9	60 pJ[3]	775 nJ[3]	60 mW	–	–	–	10000	1	10	Silicon	ND2	532
1140727	J-10SI-LE	0.325 to 0.9	8 pJ[3]	80 nJ[3]	6 mW	–	–	–	10000	1	10	Silicon	ND2	532
1140408	J-10GE	0.8 to 1.7	200 pJ[4]	600 nJ[4]	15 mW	–	–	–	10000	1	10	Germanium	ND2	1064

[1] Heat Sink. [2] Diffuse metallic. [3] At 532 nm. [4] At 1064 nm.

EnergyMax Sensors

MaxBlack Coating

J-50MB-HE, J-25MB-HE, J-10MB-HE

Features

- **Unique MaxBlack coating increases damage threshold, allows high repetition rate operation, and improves mechanical durability**
- **Operate over the 190 nm to 12 µm range**
- **Enable pulse energy measurements from 300 nJ to 2J with high signal-to-noise characteristics**
- **Measure single shot to 1 kHz repetition rate**
- **Spectral compensation characteristics built into each unit**
- **Onboard sensors provide automatic temperature compensation**

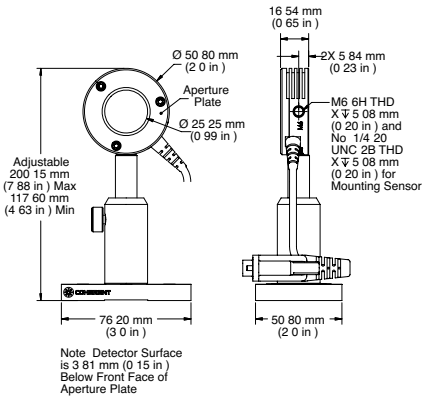
These sensors allow measurements over a wide range of wavelengths, beam diameters, average power levels, and repetition rates. The MaxBlack coating on these sensors provides significant damage resistance and mechanical durability characteristics compared to the black paint coatings often used on broadband sensors in the past.

Device Specifications

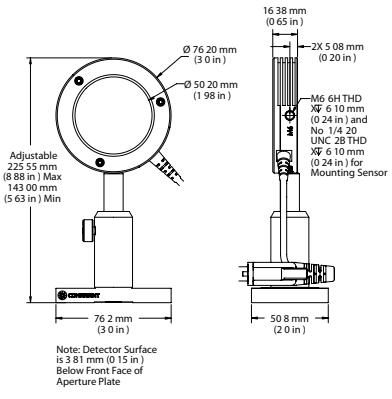
Model	J-50MB-HE	J-50MB-LE	J-25MB-HE	J-25MB-LE	J-10MB-HE	J-10MB-LE
Energy Range	1 mJ to 2J	250 µJ to 500 mJ	500 µJ to 1J	25 µJ to 50 mJ	10 µJ to 20 mJ	300 nJ to 600 µJ
Noise Equivalent Energy	<33 µJ	<8 µJ	<16 µJ	<1 µJ	<0.5 µJ	<20 nJ
Wavelength Range (µm)	0.19 to 12					
Active Area Diameter (mm)	50	50	25	25	10	10
Maximum Average Power (W)[1]	10	10	5	5	4	4
Maximum Pulse Width (µs)	57		17			
Maximum Repetition Rate (pps)	300	300	1000	1000	1000	1000
Maximum Energy Density (mJ/cm²)	500 (at 1064 nm, 10 ns)					
Detector Coating	MaxBlack					
Diffuser	No					
Calibration Wavelength (nm)	1064					
Calibration Uncertainty (%)	±2					
Energy Linearity (%)	±3					
Cable Length (m)[2]	2.5					
Cable Type	J DB-25					
Part Number	1110573	1110576	1110746	1110743	1110843	1110855

[1] Extend average power range with optional heat sink. See page 55 and 64.
[2] Cable lengths up to 10m possible. Contact factory.

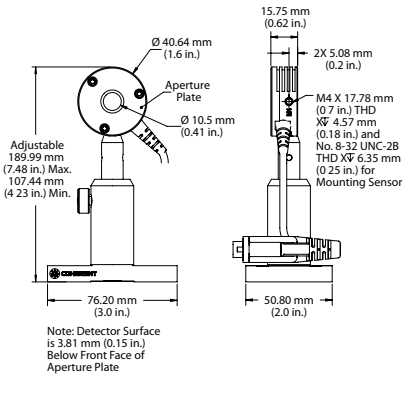
J-25MB-HE and -LE



J-50MB-HE and -LE



J-10MB-HE and -LE



EnergyMax Sensors

Diffuse Metallic Coating

J-50MT-10KHZ, J-25MT-10KHZ, J-10MT-10KHZ

Features

- **Unique diffuse metallic coating delivers increased damage threshold, allows high repetition rate operation and reduces specular reflectance**
- **Operate over the entire 190 nm to 2.1 µm range**
- **Enable pulse energy measurements from 100 nJ to 1J with high signal-to-noise characteristics**
- **Measure up to 10 kHz repetition rate**
- **Spectral compensation characteristics built into each unit**
- **Onboard sensors provide automatic temperature compensation[1]**

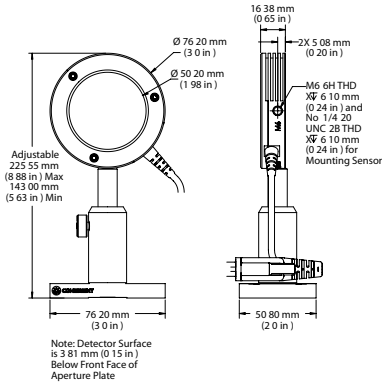
These sensors use a diffuse metallic coating that enables measurements at high and low repetition rates across a wide range of energies, wavelengths and beam sizes. The damage resistance at 532 nm and shorter wavelengths is even greater than the MaxBlack coating. These are great all-purpose sensors for the 190 nm to 2.1 µm region and offer the lowest energy range of our EnergyMax line.

Device Specifications

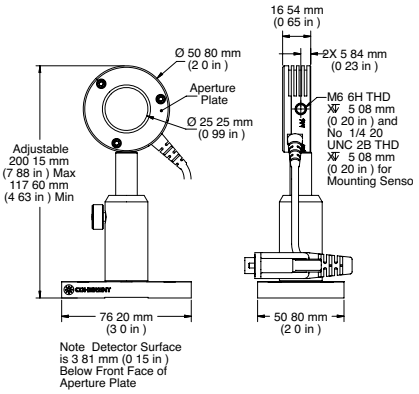
Model	J-50MT-10KHZ	J-25MT-10KHZ	J-10MT-10KHZ
Energy Range	500 µJ to 1J[2]	50 µJ to 100 mJ	100 nJ to 200 µJ
Noise Equivalent Energy	<16 µJ	<2 µJ	<10 nJ
Wavelength Range (µm)		0.19 to 2.1	
Active Area Diameter (mm)	50	25	10
Maximum Average Power (W)[3]	20	10	1
Maximum Pulse Width (µs)		1.7	
Maximum Repetition Rate (pps)		10,000	
Maximum Energy Density (mJ/cm²)	500 (at 1064 nm, 10 ns)		50 (at 1064 nm, 10 ns)
Detector Coating		Diffuse Metallic	
Diffuser		No	
Calibration Wavelength (nm)		1064	
Calibration Uncertainty (%)		±2	
Energy Linearity (%)		±3	
Cable Length (m)[4]		2.5	
Cable Type		J DB-25	
Part Number	1110574	1110747	1110856

[1] Except J-10MT-10KHZ.
[2] Optional energy range 50 µJ to 100 mJ available.
[3] Extend average power range with optional heat sink. See page 55 and 64.
[4] Cable lengths up to 10m possible. Contact factory.

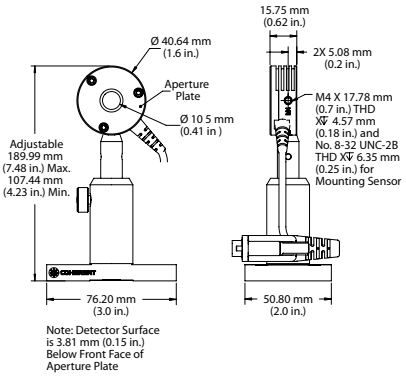
J-50MT-10KHZ



J-25MT-10KHZ



J-10MT-10KHZ



EnergyMax Sensors

MaxBlack Coating and Diffusers

J-50MB-YAG and J-25MB-IR

Features

- **High energy and peak power to 14 J/cm²**
- **Operate at Nd: YAG fundamental and harmonics, and throughout the IR**
- **Enable pulse energy measurements from 1 mJ to 15J[1]**
- **Spectral compensation characteristics built into each unit**
- **Onboard sensors provide automatic temperature compensation**
- **No need to either change diffusers during use or perform your own spectral calibrations**

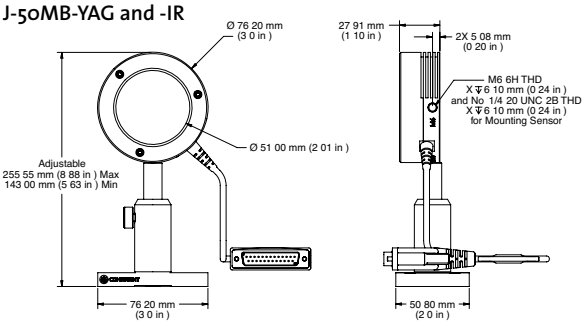
These sensors are specifically designed for high energy and high peak power lasers operating at relatively low repetition rates, such as those based on Nd:YAG, Ruby, Ho:YAG and Erbium. The J-50MB-YAG sensor can be used with beams up to 35 mm in diameter and can work at 1064 nm, 532 nm, 355 nm and 266 nm without the need to change or self-calibrate diffusers or any other accessories. Both sensors combine a MaxBlack coating and a diffuser to produce superior damage resistance characteristics. This combination enables operation with lasers that produce either very high energy per pulse or very high peak fluences.

Device Specifications

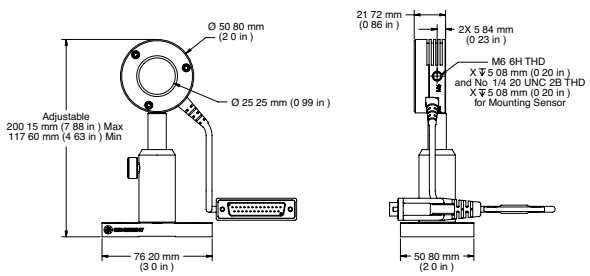
Model	J-50MB-YAG	J-50MB-IR	J-25MB-IR
Energy Range	1.5 mJ to 3J[1]	1.0 mJ to 3J	1.5 mJ to 3J
Noise Equivalent Energy (µJ)	<50	<100	<50
Wavelength Range (µm)	0.266 to 2.1	0.5 to 3.0	0.532 to 2.1
Maximum Beam Size (mm)	35	30	12.5
Maximum Average Power (W)[2]	20	15	20
Maximum Pulse Width (µs)	340	1000	860
Maximum Repetition Rate (pps)	50	30	20
Maximum Energy Density (J/cm²)	14.0 (at 1064 nm, 10 ns) 2.8 (at 532 nm, 10 ns) 0.75 (at 355 nm, 10 ns) 1.0 (at 266 nm, 10 ns)	>100 (at 2940 nm, 100 µs)	5.0 (at 1064 nm, 10 ns)
Detector Coating	MaxBlack	MaxBlack	MaxBlack
Diffuser	YAG	IR	IR
Calibration Wavelength (nm)	1064	1064, 2940	1064
Calibration Uncertainty (%)	±2	±2	±3
Energy Linearity (%)	±3	±3.5	±3
Cable Length (m)[3]	2.5	2.5	2.5
Cable Type	J DB-25	J DB-25	J DB-25
Part Number	1110744	1155722	1110577

[1] Modifed sensors with higher repetition rate, energy range and/or pulse width are available. Contact factory.
[2] Extend average power range with optional heat sink. See page 55 and 64.
[3] Cable lengths up to 10m possible. Contact factory.

J-50MB-YAG and -IR


Ø 76 20 mm (3 0 in)
Ø 51 00 mm (2 01 in)
Adjustable
255 55 mm (8 88 in) Max
143 00 mm (5 63 in) Min
76 20 mm (3 0 in)
27 91 mm (1 10 in)
2X 5 08 mm (0 20 in)
M6 6H THD
X ⧩6 10 mm (0 24 in)
and No 1/4 20 UNC 2B THD
X ⧩6 10 mm (0 24 in)
for Mounting Sensor
50 80 mm (2 0 in)

J-25MB-IR


Ø 50 80 mm (2 0 in)
Ø 25 25 mm (0 99 in)
Adjustable
200 15 mm (7 88 in) Max
117 60 mm (4 63 in) Min
76 20 mm (3 0 in)
21 72 mm (0 86 in)
2X 5 84 mm (0 23 in)
M6 6H THD
X ⧩5 08 mm (0 20 in)
and No 1/4 20 UNC 2B THD
X ⧩5 08 mm (0 20 in)
for Mounting Sensor
50 80 mm (2 0 in)

EnergyMax Sensors

MaxUV Coating

J-50MUV-248 and J-25MUV-248

Features

- **Unique MaxUV coating delivers highest DUV damage threshold and long-term UV exposure resistance**
- **Operate over the 190 nm to 2.1 µm range**
- **Enable pulse energy measurements from 50 µJ to 1J**
- **Measure up to 400 Hz repetition rate**
- **Spectral compensation characteristics built into each unit**
- **Onboard sensors provide automatic temperature compensation**

MaxUV-coated EnergyMax sensors are specifically optimized for use with ArF lasers operating at 193 nm and KrF lasers at 248 nm. These sensors feature high accuracy and large active areas (up to 50 mm), and use a unique coating called MaxUV that delivers superior long-term damage resistance.

Two of the 50 mm diameter models incorporate a DUV quartz diffuser for increased resistance to coating damage.

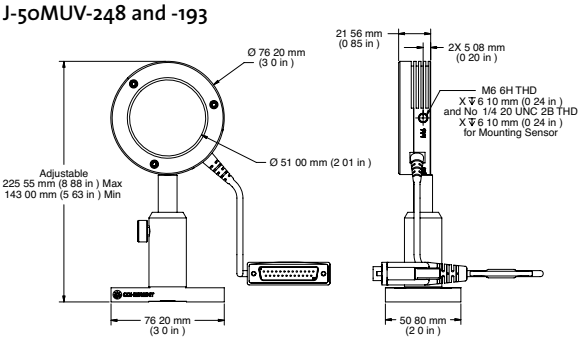
Device Specifications

Model	J-50MUV-248 w/o Diffuser	J-50MUV-248 w/Diffuser	J-50MUV-193 w/o Diffuser	J-50MUV-193 w/Diffuser	J-25MUV-248 w/o Diffuser	J-25MUV-193 w/o Diffuser
Energy Range	500 µJ to 1J	500 µJ to 1J	125 µJ to 250 mJ	125 µJ to 250 mJ	125 µJ to 250 mJ	50 µJ to 100 mJ
Noise Equivalent Energy (µJ)	<16	<16	<4	<4	<4	<2
Wavelength Range (µm)	0.19 to 2.1	0.19 to 0.266	0.19 to 2.1	0.19 to 0.266	0.19 to 2.1	0.19 to 2.1
Active Area Diameter (mm)	50	50	50	50	25	25
Max. Average Power (W)[1]	10	15	10	18	5	5
Max. Pulse Width (µs)	86	86	86	86	43	43
Max. Rep. Rate (pps)	200	200	200	200	400	400
Max. Energy Density (mJ/cm²)	260 (at 248 nm, 10 ns)	520 (at 248 nm, 10 ns)	200 (at 193 nm, 10 ns)	400 (at 193 nm, 10 ns)	260 (at 248 nm, 10 ns)	200 (at 193 nm, 10 ns)
Detector Coating	MaxUV					
Diffuser	No	DUV	No	DUV	No	No
Calibration Wavelength (nm)	248	248	193	193	248	193
Calibration Uncertainty (%)	±3					
Energy Linearity (%)	±3					
Cable Length (m)[2]	2.5					
Cable Type	J DB-25					
Part Number	1146243	1110572	1146237	1110575	1110745	1110741

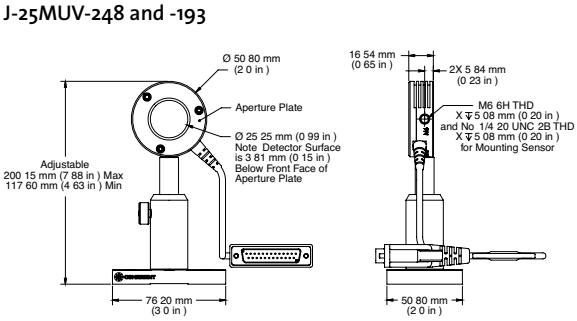
[1] Extend average power range with optional heat sink. See page 55 and 64.

[2] Cable lengths up to 10m possible. Contact factory.

J-50MUV-248 and -193


Ø 76 20 mm
(3 0 in)
Adjustable
225 55 mm (8 88 in) Max
143 00 mm (5 63 in) Min
Ø 51 00 mm (2 01 in)
76 20 mm
(3 0 in)
21 56 mm
(0 85 in)
2X 5 08 mm
(0 20 in)
M6 6H THD
X ↧6 10 mm (0 24 in)
and No 1/4 20 UNC 2B THD
X ↧6 10 mm (0 24 in)
for Mounting Sensor
50 80 mm
(2 0 in)

J-25MUV-248 and -193


Ø 50 80 mm
(2 0 in)
Aperture Plate
Ø 25 25 mm (0 99 in)
Note Detector Surface
is 3 81 mm (0 15 in)
Below Front Face of
Aperture Plate
Adjustable
200 15 mm (7 88 in) Max
117 60 mm (4 63 in) Min
76 20 mm
(3 0 in)
16 54 mm
(0 65 in)
2X 5 84 mm
(0 23 in)
M6 6H THD
X ↧5 08 mm (0 20 in)
and No 1/4 20 UNC 2B THD
X ↧5 08 mm (0 20 in)
for Mounting Sensor
50 80 mm
(2 0 in)

EnergyMax Sensors

Quantum Series

J-10SI-LE

Features

- **Pulse enegy measurement down to 8 pJ (within line; model dependent)**
- **Average power measurement of pulsed sources from nW to mW level signal-to-noise characteristics**
- **Measures single pulses to 10,000 Hz**
- **Accurate spectral compensation**
  - 325 nm to 900 nm for Silicon
  - 800 nm to 1700 nm for Germanium
- **Robust and reliable construction**

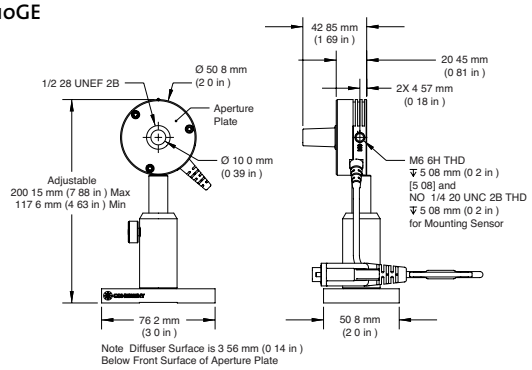
Quantum EnergyMax sensors enable low energy pulse measurements down to the 8 pJ level , as well as average power of pulsed systems from the nW to mW level, across a broad range of wavelengths. These sensors have a removable light shield on the front used to block stray light.

Device Specifications

Model	J-10SI-LE	J-10SI-HE	J-10GE
Energy Range	8 pJ to 80 nJ (@ 532 nm)	60 pJ to 775 nJ (@ 532 nm)	200 pJ to 600 nJ (@ 1064 nm)
Noise Equivalent Energy	<0.8 pJ (@ 532 nm)	<6 pJ (@ 532 nm)	<8 pJ (@ 1064 nm)
Wavelength Range (nm)	325 to 900	325 to 900	800 to 1700
Active Area Diameter (mm)	10	10	10
Max. Avg. Power (mW)	6	60	15
Max. Pulse Width (µs)	1	1	1
Max. Rep. Rate (pps)	10,000	10,000	10,000
Sensor	Silicon	Silicon	Germanium
Diffuser	ND2	ND2	ND2
Calibration Wavelength (nm)	532	532	1064
Calibration Uncertainty (%)	±3	±3	±3
Linearity (%)	±3	±3	±3
Cable Length (m)[1]	3	3	3
Cable Type	J DB-25	J DB-25	J DB-25
Part Number	1140727	1150146	1140408

[1] Cable lengths up to 10m possible. Contact factory.

J-10SI-LE and -HE/J10GE


42 85 mm
(1 69 in)
20 45 mm
(0 81 in)
2X 4 57 mm
(0 18 in)
1/2 28 UNEF 2B
Ø 50 8 mm
(2 0 in)
Aperture
Plate
Ø 10 0 mm
(0 39 in)
Adjustable
200 15 mm (7 88 in) Max
117 6 mm (4 63 in) Min
M6 6H THD
↧ 5 08 mm (0 2 in)
[5 08] and
NO 1/4 20 UNC 2B THD
↧ 5 08 mm (0 2 in)
for Mounting Sensor
76 2 mm
(3 0 in)
50 8 mm
(2 0 in)
Note Diffuser Surface is 3 56 mm (0 14 in)
Below Front Surface of Aperture Plate

EnergyMax Sensors

Quantum Series

The Quantum EnergyMax series consists of three different models that provide very low pulse energy measurement down to 20 pJ. Two of the models (J-10SI-LE and J-10SI-HE) incorporate a Silicon photodiode, and one model (J-10GE) incorporates a Germanium photodiode. All three models contain large 10 mm clear apertures and operate at repetition rates from single pulse up to 10 kHz.

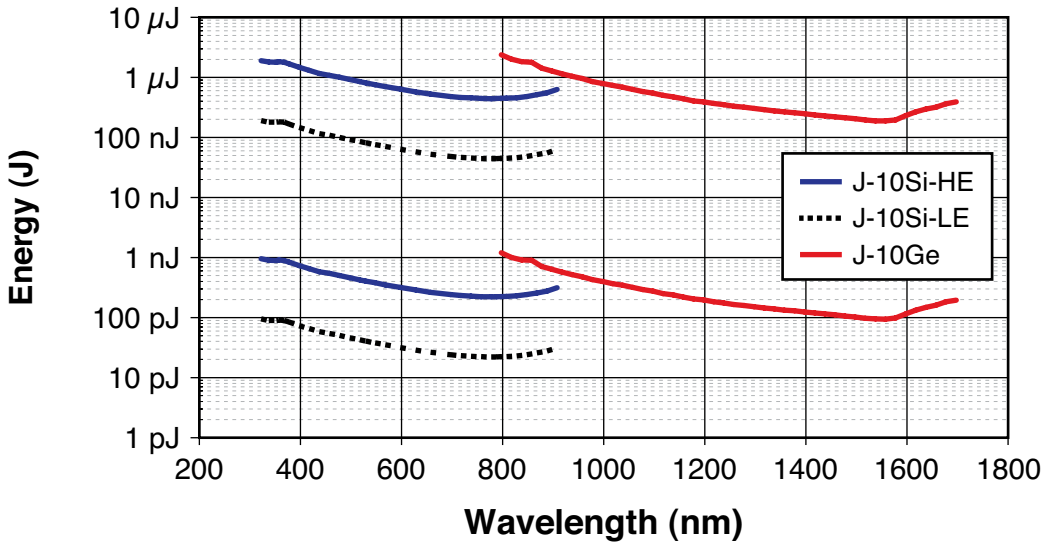
The main difference between Quantum EnergyMax sensors and other Coherent EnergyMax sensors is their sensitivity. Quantum EnergyMax sensors are capable of measuring considerably smaller signals than the rest of the EnergyMax sensor line. They do this by utilizing a photodiode—rather than a pyroelectric—element.

Due to the quantum nature of their response, photodiode sensors are inherently more sensitive than pyroelectric sensors, which are thermal-based. One consequence of this extra sensitivity is the possibility of measurement error or noise from stray modulated light sources (for example, stray reflections or room lights) in a laboratory environment. For this reason Quantum EnergyMax sensors are designed for use with a small integrated input beam tube, which limits the field of view of the sensor aperture. This tube is removable for alignment purposes and custom applications.

The following chart plots the minimum and maximum measurable energy of each sensor across all wavelengths. This chart can be used to determine the measurable energy range for wavelengths other than those in the specifications table (1064 nm and 532 nm).

LabMax-TOP and J-10SI-LE

Spectral Sensitivity Curves for Quantum EnergyMax Sensors



EnergyMax Accessories

Heat Sinks

EnergyMax Heat Sinks

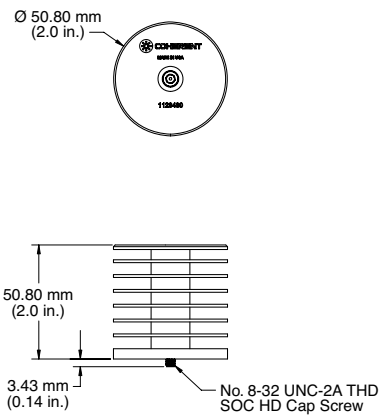
Features

- Extend EnergyMax average power
- Easily attach to EnergyMax sensors in the field
- Two heat sinks for 25 mm sensors (small and medium)
- One heat sink for 50 mm sensors (large)

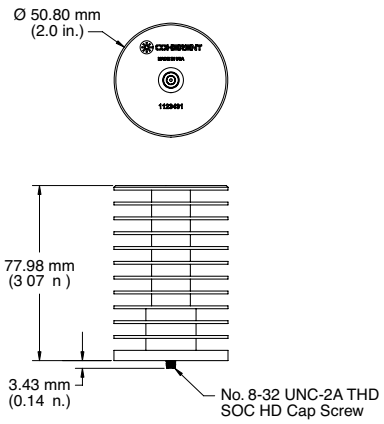
These heat sink accessories can be used to extend the energy and repetition rates of EnergyMax sensors by increasing the average power capability. Easily installed, they are simply theaded onto the back of a sensor housing with a cap screw retained within the heat sink.

The small and medium models, for use with sensors that have a 25 mm diameter aperture, increase the average power handling into the 10W to 30W range (coating and wavelength dependent). The large heat sink, for use with 50 mm diameter aperture sensors, increases the average power handling into the 20W to 40W range (coating and wavelength dependent). See Average Power Capability table on page 55 for sensor specifications.

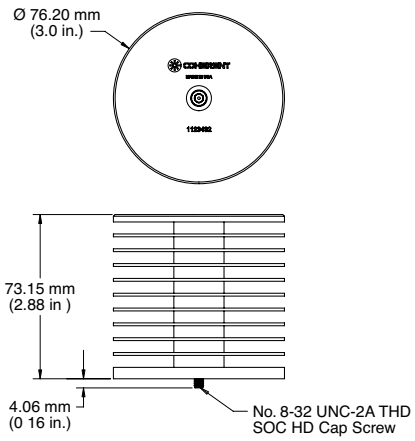
Small Heat Sink



Medium Heat Sink



Large Heat Sink



Part Number	Description
1123430	Small Heat Sink
1123431	Medium Heat Sink
1123432	Large Heat Sink

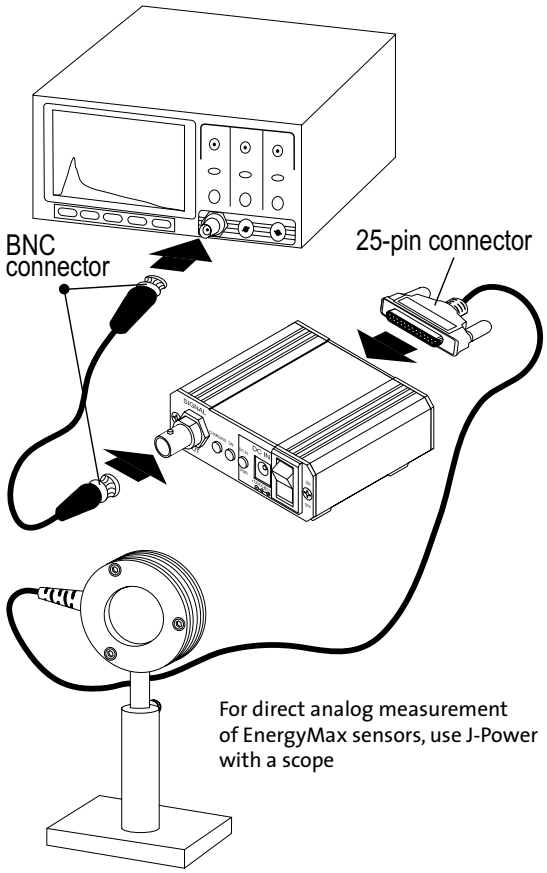
EnergyMax Accessories

J-Power Energy Sensor DB-25-to-BNC Adapter

J-Power

The J-Power is a compact sensor adapter that powers the EnergyMax active sensor circuit and passes the raw output voltage of the sensor directly to the BNC connector. The peak voltage of the output (as referenced from baseline voltage) can then be measured using an oscilloscope or other analog-to-digital input device. The calibrated peak voltage represents the integrated energy of the laser pulse.

Part Number	Description
1132205	J-Power Energy Sensor Adapter



Pyroelectric Sensor Test Slides

Test Slides

For protection of your sensor when measuring unknown beams, the test slide is inserted into the beam and then examined for damage. These test slides are coated with the same absorbing coating as the pyroelectric sensors. If coating damage is visible, then attenuation is required before measuring the beam.

Part Number	Description
0011-4311	Pyroelectric Test Slide – Black Coating (used with legacy sensors)
1129175	Pyroelectric Test Slide – Diffuse Metallic Coating
0011-4313	Pyroelectric Test Slide – MUV Coating
0011-4314	Pyroelectric Test Slide – MB Coating

EnergyMax - Laser Energy Sensors

Measuring Energy with an Oscilloscope

To measure the energy of very high repetition rate and/or low-energy lasers, an oscilloscope can be used to monitor the output of an EnergyMax sensor.

This page presents a step-by-step procedure for setting up an oscilloscope and using a pyroelectric EnergyMax sensor to accurately read a peak voltage output.

1. To assure the accuracy of a pulse energy measurement, make sure the oscilloscope is calibrated properly. Also check the date for when the oscilloscope is due for recalibration.

2. Select a scope that has a sensitivity of at least 2 mV and a bandwidth of at least 20 MHz.

3. To connect an EnergyMax sensor to an oscilloscope you will need a J-POWER DB25-to-BNC accessory (available from Coherent).

4. Use the 1 Mohm input impedance of the oscilloscope when connecting any EnergyMax sensor.

5. Set up the scope as follows:
   - Bandwidth to 20 MHz
   - DC coupling
   - Trigger on "+" slope and "internal" source, or use the laser sync output and "external" source

6. Estimate the approximate EnergyMax sensor voltage output expected, based on the Rv (V/J) of the sensor (available on both the calibration certificate and the calibration sticker attached to the sensor cable), and the typical laser pulse energy.

7. If you know your expected laser pulse repetition rate, set the scope time base to show 2 pulses on the screen. This helps set the trigger and allows observation of the true "baseline" of the pulse. For example, for a laser running at 10 pps, set the scope time base to 20 msec/division. Once proper triggering occurs, use the vertical adjust to set the baseline of the EnergyMax voltage pulse to coincide with a horizontal grid line (see Figure 1). This setting becomes the zero for the peak voltage reading.

8. Adjust the "time base" of the scope to show a single EnergyMax pulse and then focus on the leading edge to accurately read the peak voltage (see Figure 2).

To avoid affecting the calibration of the sensor with a coaxial cable do not lengthen the cable when using the sensor with the oscilloscope.

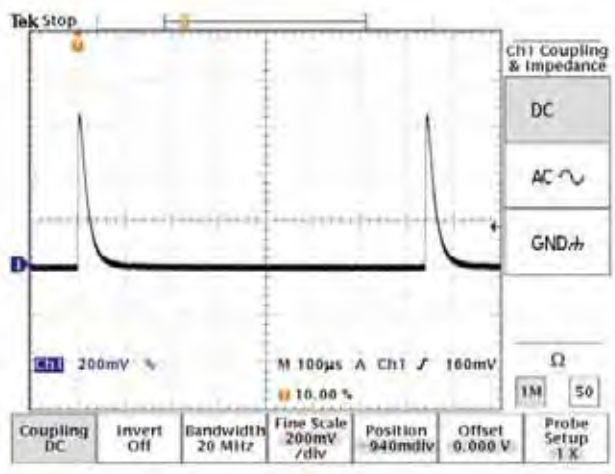


Figure 1

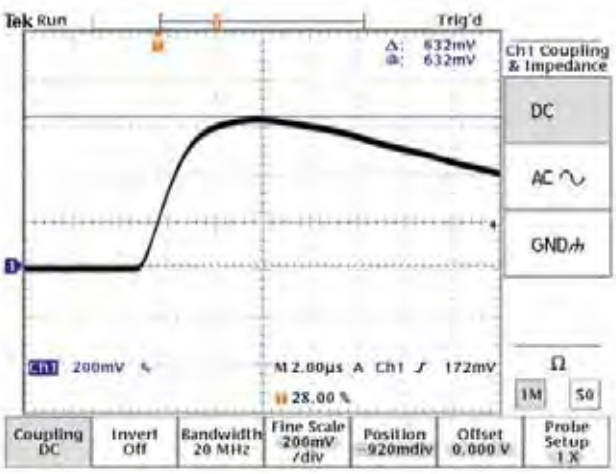


Figure 2

Miscellaneous Energy Sensors

J100 Energy Sensor

J100

Features

- Large-area 95 mm diameter
- Broad spectral response 0.3 to 12 µm
- Wide dynamic range of 0.4 mJ to 5J
- High average power to 20W
- JSA-BNC adapter (1098306) needed for use with FieldMaxII-TOP and LabMax-TOP

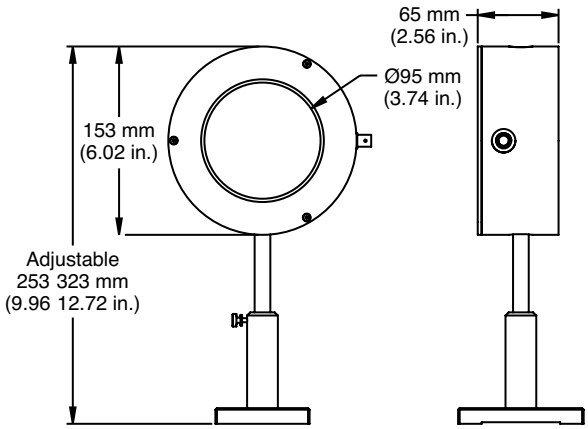
The J100 is a pyroelectric energy sensor with a flat, broad spectral response calibrated at 1064 nm. The 95 mm diameter active area is ideal for divergent sources and pulsed lasers used in applications such as laser range finding. The sensor output is through a BNC connector and the product ships with a 1.5 m BNC cable.

Device Specifications

Model	J100
Wavelength Range (µm)	0.3 to 12
Energy Range[1]	0.4 mJ to 5J
Max. Avg. Power	20
Typical Response (Rv) (V/J)	3
Max. Rep. Rate (pps)	50
Max. Pulse Width (µs)	200
Detector Coating	Black
Detector Diameter (mm)	95
Dimensions (mm)	Ø 153 x 65
Calibration Uncertainty (%)	±2
Calibration Wavelength (nm)	1064
Connector Type	BNC
Cable Length (m)	1.5 (separate)
Part Number	0011-6100

[1] Maximum energy is pulse-width dependent.

J100



Custom and OEM Products Introduction

Complete Laser Measurement and Control Solutions

Laser system integrators frequently include laser measurement products in their systems to monitor system performance and status, or to provide real-time feedback for laser system control. In these instances custom measurement solutions or modifications to our existing products may be necessary due to size or performance constraints.

Coherent is well positioned to provide custom and modified measurement products. Following are some examples of services and products Coherent offers.

OEM Power and Energy Sensors
We provide an extensive line of OEM thermopile and energy sensors. Usually, a standard or existing modified standard product will fit your application.

Power Sensors
- Compact thermopile power sensors
- Water-cooled and air-cooled options
- BNC and 4-pin Molex signal output options
- Thermopile disks for integrating into heat-sinked applications
- Any standard thermopile with a cable can be integrated with an off-the-shelf interface module

Energy Sensors
- BNC-terminated energy sensors
- Compact designs to fit in tight locations
- A customer-supplied peak detection module or a Coherent meter or custom signal conditioning board is required

Off-the-Shelf Interface Modules
Several off-the-shelf electronic modules provide signal conditioning, measurement, and communication outputs.

Power Modules
- Amplification for very low power applications
- Noise filtering
- Analog output
- PC interfacing
- Beam position monitoring

Energy Modules
- Baseline and peak detection capabilities
- Noise filtering for greater peak detection accuracy
- Repetition rates as high as 100 kHz

Custom Measurement Products
Sometimes a completely custom product is required for a particular application. Our research and development teams of electrical, mechanical and software engineers, physicists, chemists and materials scientists can provide measurement systems to meet the most complex challenges. By involving Coherent early in your design phase we can provide the very best solution.

- Custom detectors and sensors
- Interface modules with unique communication protocols
- Extremely low energy and/or high repetition rate energy measurement

Modified Standard Products
Sometimes a slight modification to a standard catalog product is all that is needed to enable a special application.

Mechanical
- Longer or shorter cable
- Different type of connector
- Slight mechanical change

Calibration
- Different calibration wavelength

OEM Thermopiles

10 mW to 150W

Models PM10-19A, PM10-19B, PM150-50A

Features

- **10 mW to 150W**
- **Spectrally flat from 0.19 µm to 11 µm**
- **Compact designs**
- **Air-cooled or water-cooled**
- **Active area diameters from 19 mm to 50 mm**

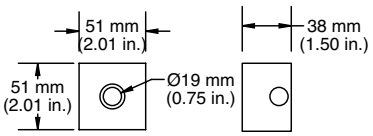
The sensors on the next two pages are small, compact OEM thermopiles designed for use in embedded applications. Power ratings are provided for water-cooled and air-cooled installations (see page 18 for additional air-cooled ratings for various exposure times). For conductively-cooled installations a good approximation is that doubling the surface area of the sensor housing doubles the air-cooled rating.

Models that end with "A" are amplified sensors with a 4-pin connector. They must be supplied with ±15 VDC and draw less than 20 mA. Models that end with "B" are passive sensors with a BNC output. Models with DB25 cables that are compatible with our instruments end with a "C" and can be found on page 29.

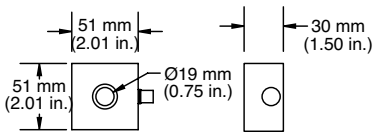
Device Specifications

Model	PM10-19A	PM10-19B	PM150-19A	PM150-19B	PM150-50A
Wavelength Range (µm)	0.19 to 11				
Resolution (mW)	1	1	30	30	30
Min. Water flow (gpm)	0.02	0.02	0.2	0.2	0.2
Max. Avg. Power (water-cooled) (W)	10		150		
Max. Avg. Power (air-cooled, 5 min.) (W)	5		20		80
Responsivity (typ.)	1 V/W	1 mV/W	40 mV/W	0.4 mV/W	40 mV/W
Max. Power Density	26 kW/cm²				
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns				
Response Time (sec.)	1	2	1	2	1
Detector Coating	Broadband				
Active Area Diameter (mm)	19				
Dimensions (mm)	51 x 51 x 38 (2.0 x 2.0 x 1.4 in.)	51 x 51 x 30 (2.0 x 2.0 1.1 in.)	51 x 51 x 38 (2.0 x 2.0 x 1.4 in.)	51 x 51 x 30 (2.0 x 2.0 1.1 in.)	89 x 89 x 38 (3.5 x 3.5 x 1.4 in.)
Calibration Uncertainty (%)	±1				
Calibration Wavelength (nm)	514				
Cooling Method	Water-cooled				
Connector Type	4-pin Molex 22-12-2044	BNC-terminated	4-pin Molex 22-12-2044	BNC-terminated	4-pin Molex 22-12-2044
Cable Length (m)	–	–	–	–	–
Part Number (RoHS)	1098334	1098343	1098418	1098321	1098510

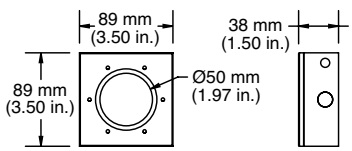
PM10-19A/PM150-19A



PM10-19B/PM150-19B



PM150-50A



OEM Thermopiles

300 mW to 1 kW

Model PM150-50B, **PM150-50XB, PM1K-36B, BeamFinder**

Features

- 300 mW to 1 kW
- Spectrally flat from 0.19 µm to 11 µm
- Compact designs
- Air-cooled or water-cooled
- Active area diameters from 19 mm to 50 mm
- Supplied with water fittings

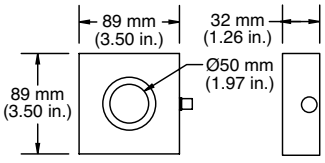
BeamFinder: Use with LabMax (see page 10)

Device Specifications

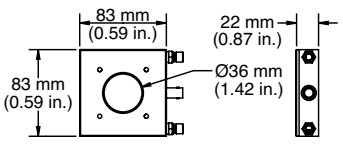
Model	PM150-50B	PM150-50XB	PM1K-36B	BeamFinder[1]
Wavelength Range (µm)	0.19 to 11	0.15 to 1	0.19 to 11	0.3 to 10.6
Resolution (mW)	30	30	1000	1000
Min. Water flow (gpm)	0.2	0.2	1.0	1.0
Max. Avg. Power (water-cooled) (W)	150		1000	
Max. Avg. Power (air-cooled, 5 min.) (W)	80		40	–
Responsivity (typ.)	0.4 mV/W		0.1 mV/W	–
Max. Power Density	26 kW/cm²			2.5 kW/cm²
Max. Energy Density	0.6 J/cm², 1064 nm, 10 ns			0.5 J/cm², 1064 nm, 10 ns
Response Time (sec.)	5			10
Detector Coating	Broadband	UV	Broadband	H
Active Area Diameter (mm)	50		36	35
Dimensions (mm)	89 x 89 x 32 (3.5 x 3.5 x 1.2 in.)		83 x 83 x 22 (3.2 x 3.2 x 0.8 in.)	84 x 84 x 25.4 (3.3 x 3.3 x 1.0 in.)
Calibration Uncertainty (%)	±1		±5	
Calibration Wavelength (nm)	514		1064	10,600
Cooling Method	Water-cooled			
Connector Type	BNC-terminated			LM DB-25
Cable Length (m)	–	–	–	6
Part Number (RoHS)	1098415	1098441	1098333	1098427

[1] BeamFinder incorporates a quadrant thermopile disk that enables the position of the beam to be sensed.

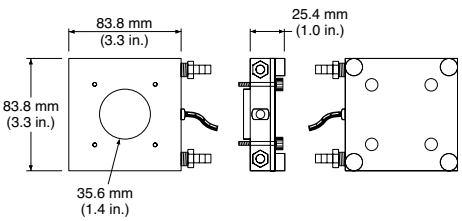
PM150-50B/PM150-50XB



PM1K-36B



BeamFinder



Custom and OEM Products

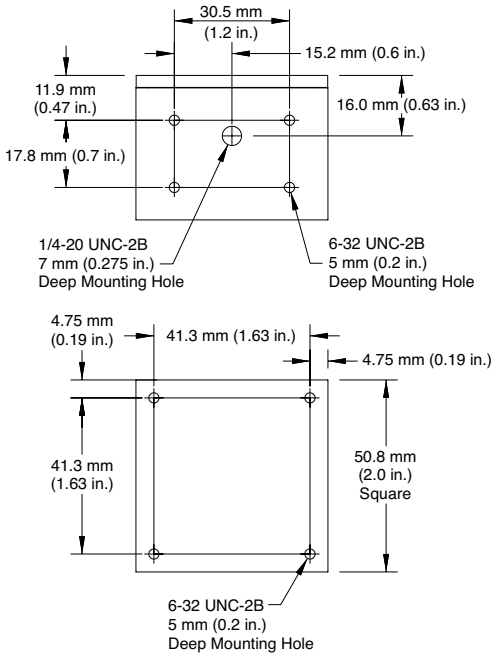
Complete Laser Measurement and Control Solutions

Additional electrical connection, water fitting, and mounting details for several of our OEM thermopiles can be found below.

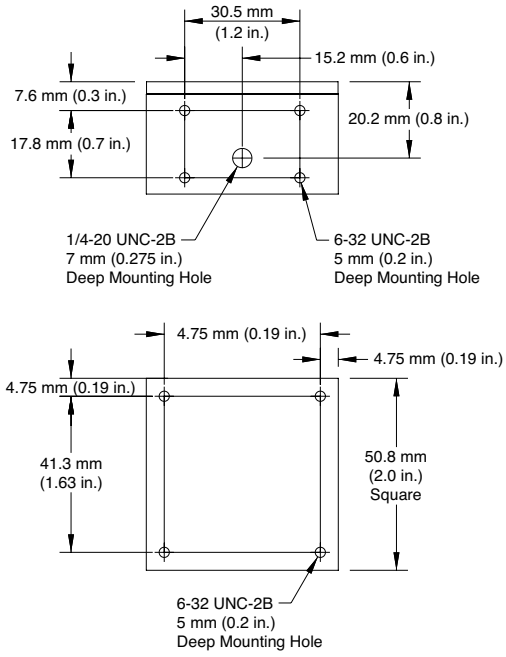
PM10-19A, PM150-19A, PM150-50A
Style: Active amplified output
Input/Output connector: 4-pin, Molex part no. 22-12-2044
pin 1: -10 to -20V power input
pin 2: Ground
pin 3: +10 to +20V power input
pin 4: Output signal
Current draw: Approx. 8 mA at -15 V, Approx. 18 mA at +15 V
Output impedance: 100 Ohm
Water connections: 1/8 NPT

PM10-19B, PM150-19B, PM150-50B, PM150-50XB, PM1K-36B
Style: Passive output
Output connector: BNC
Output impedance: 2500 Ohm
Water connections: 1/8 NPT

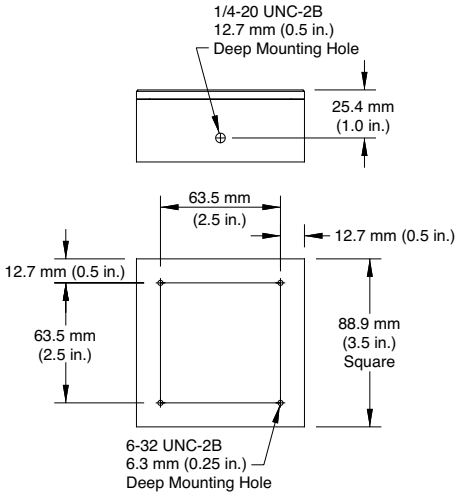
PM10-19A/ PM150-19A



PM10-19B/ PM150-19B

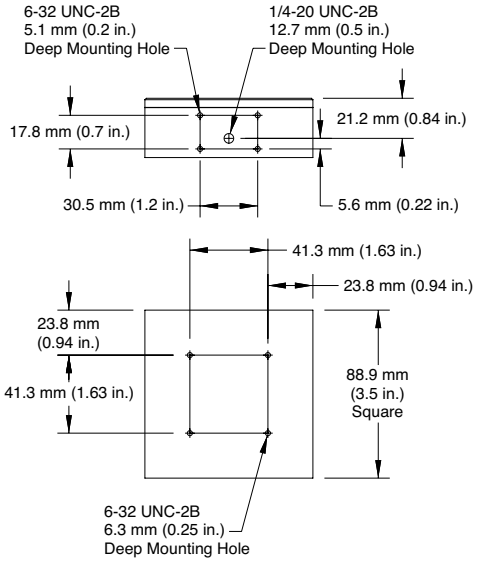


PM150-50A



* Requires 15 VDC power input

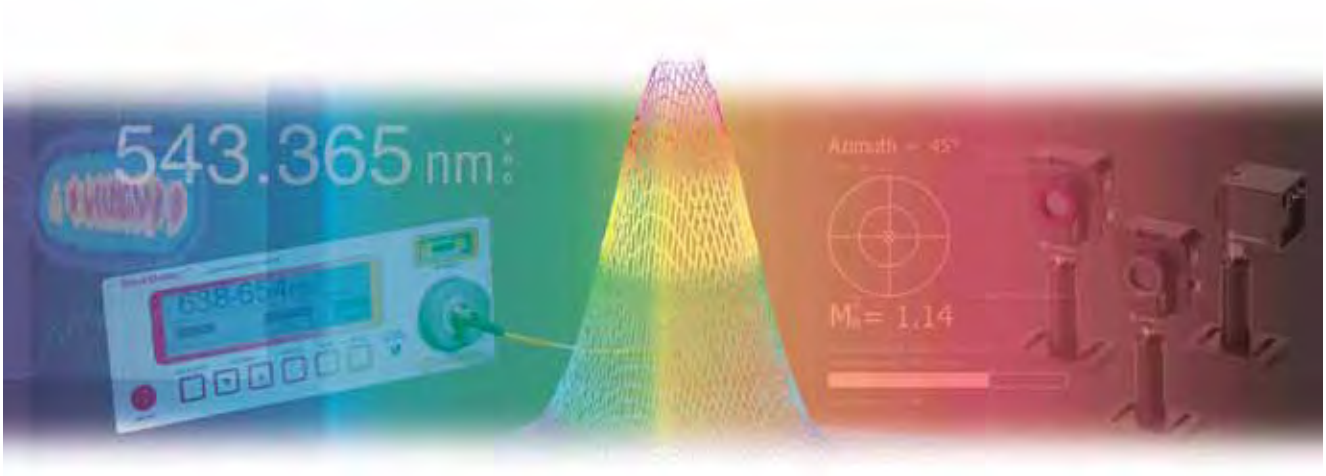
PM150-50B/ PM150-50XB



Beam Diagnostics Introduction

Introduction to Laser Beam Diagnostics

In today's fast-paced photonics market it is important to understand the technical specifications of highly complex laser systems and their applications. As well as analyzing the power or energy, it is also useful to understand the shape, intensity profile, and propagation of a laser beam. For over 25 years Coherent has developed precision instruments that measure,



Beam Profilers

As a laser beam propagates, changes in the laser cavity, as well as changes in divergence and interactions with optical elements, cause the width and spatial intensity of the beam to change in space and time. Spatial intensity distribution is a fundamental parameter for indicating how a laser beam will behave in any application. And while theory can sometimes predict the behavior of a beam, tolerance ranges in mirrors and lenses, as well as ambient conditions affecting the laser cavity and beam delivery system, necessitate verification.

Two types of beam profilers are available: those that use special cameras as the beam detectors (these are excellent for fast and detailed analyses of the intensity profile of pulsed and CW lasers); and systems that use moving knife-edges (these have a large dynamic range and can accurately measure small and focused beams). Coherent has both of these types available: the camera-based LaserCam-HR on pages 74 to 75 and an advanced knife-edge system—BeamMaster—on pages 85 to 87.

Beam Propagation

The Coherent ModeMaster beam propagation analyzer established an entirely new laser beam quality parameter that is now an ISO standard. M^2 is recognized as describing both how "close-to-perfect Gaussian" a beam is, and also how well the beam can be focused at its intended target.

Wavelength Meter

For many high performance tunable laser systems, or those using laser diodes, it is important to measure the wavelength. The WaveMaster laser wavelength meter accurately measures the wavelength of both CW and pulsed lasers of any repetition rate to an accuracy of 5 picometers. See page 94 for additional specifications for the WaveMaster.

Summary of Product Primary Measurement Capabilities

Model	BeamView Analyzer	BeamMaster	ModeMaster	WaveMaster
Wavelength	–	–	–	CW + Pulsed
Power / Energy	–	CW	–	–
Beam Position	CW + Pulsed	CW	CW	–
Propagation M^2	–	–	CW	–
Beam Profiles				
2D	CW + Pulsed	CW	CW	–
3D	CW + Pulsed	CW	–	–
Page Number	76	85	88	94

LaserCam-HR

Introduction to Camera-Based Beam Diagnostics

Coherent BeamView Analyzer systems are the recognized leader in software, hardware and optical components for laser beam analysis. Constant product improvement based on customer feedback, and innovation from beam analysis experts, have made BeamView Analyzer products the first choice for laboratory, factory and field measurements.

The key elements of a typical camera-based beam profiling system are the camera itself, Coherent Beamview analysis software running on an appropriate computer and, when necessary, beam attenuation optics. The key choice to make is matching the appropriate camera technology to your application.

Coherent beam diagnostic cameras are specifically designed or modified for laser analysis. They provide low noise, maximum linearity, and uniformity of response—needed for maximum measurement accuracy. All of these diagnostic cameras accept C-Mount optical accessories and are delivered without a cover (glass/plastic window) over the sensor array. Instead, a LDFP (Low-Distortion Face Plate) filter is supplied with each camera—a laser-grade neutral density filter made of glass specified and polished specifically for laser diagnostic analysis. The LDFP filter is mounted in a standard C-Mount ring and provides attenuation of ambient room light so that the camera can be used with normal room lights.

Coherent offers three families of cameras. Lasercam II and LaserCam IIID cameras use analog and digital interfacing respectively. The latest edition, LaserCam HR, is based on USB technology.

USB 2.0 Beam Diagnostic Camera Family
Coherent pioneered the ease-of-use of digital USB 2.0 bus-powered, high-resolution, large-area cameras requiring only a single cable for both video transfer and camera power. The LaserCam-HR family of beam diagnostic cameras now includes the LaserCam-HR-UV and the LaserCam-HR-InGaAs models, extending the measurement spectrum from the deep ultraviolet to the near-infrared wavelengths.

The same features, performance and convenience previously available only for wavelengths covered by the LaserCam-HR are now available to users of excimer lasers, telecommunication sources and military laser systems. With a broad spectral range covering 190 nm to 1700 nm, there is a LaserCam-HR camera profiler system ideally suited for nearly any demanding laser measurement application.

Important Considerations
- Ease-of-use connectivity
  - High-speed USB 2.0 Interface
  - USB bus-powered low voltage operation
- Broad spectral range
  - LaserCam-HR 300 nm to 1100 nm (400 to 1100 nm with LDFP) (190 to 355 nm with BIP-12F)
  - LaserCam-HR-UV DUV to 355 nm
  - LaserCam-InGaAs 900 nm to 1700 nm
- Large dynamic range
- Coherent Adaptive Pixel Technology (CAPT)
- Digital output through USB 2.0 eliminates the need for an interface card (frame-grabber)
- High-accuracy beam diameter calculations
- Excellent beam spatial uniformity
- BeamView 4.4 application software

- Variable camera exposure time
- Compact size
- High-speed image capture rates (15 to 25 frames per second)
- Pass/Fail TTL level output
- RS-232 and TCP/IP communication protocols
- Comprehensive LabVIEW library suite for the majority of BeamView-USB software functions
- All LaserCam-HR camera systems are RoHS compliant

Coherent Adaptive Pixel Technology
Coherent tests each LaserCam-HR camera through a process called CAPT (Coherent Adaptive Pixel Technology). This uses a calibrated lightsource and a digital look-up table to give pixel-to-pixel linearity correction. In addition, any identified "hot" pixel is corrected by averaging the value of the four directly surrounding pixel intensities. Finally, the noise levels are carefully monitored through both a background noise subtraction and a user-selectable bias noise offset level. The CAPT process optimizes the performance of the camera array, directly improving beam measurement accuracy, especially with beam diameter calculations.

Multiple channel camera support of different LaserCam-HR camera models is available for all three LaserCam-HR camera types (UV, visible, and InGaAs).

Variable camera exposure time available with the entire LaserCam-HR camera family allows imaging of higher repetition rate sources and lets the user decrease/increase the signal intensity levels using exposure time instead of external attenuation. This feature is especially suited for the LaserCam-HR-InGaAs, with its impressive spatial uniformity characteristics.

Beam Diagnostic Cameras

LaserCam-HR and LaserCam-HR-UV

LaserCam-HR

LaserCam-HR-UV

Features

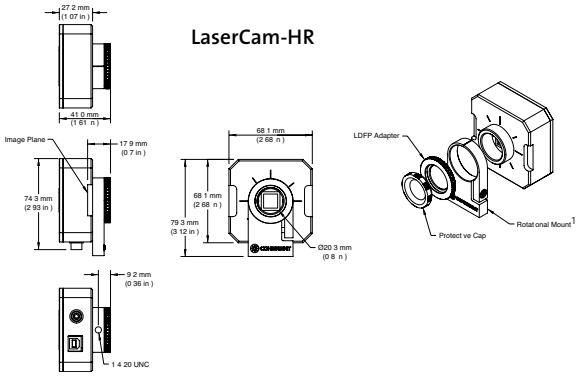
- **USB 2.0, 10-bit digital output**
- **Large-area CMOS array, 8.5 x 6.8 mm**
- **Compact 68 x 68 x 34 mm package**
- **Coherent Adaptive Pixel Technology (CAPT) pixel-by-pixel offset, linearity and blemish correction**
- **CW and pulsed operation including external triggering**
- **Variable exposure time**
- **User-variable trigger delay**
- **Long-term UV sensor stability (with the LaserCam-HR-UV camera)**
- **C-mount thread for additional accessories**

Device Specifications

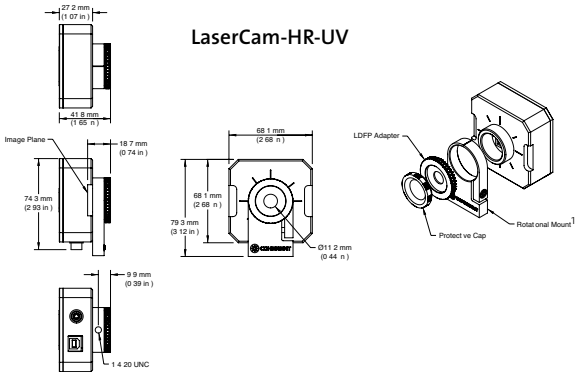
Model	LaserCam-HR	LaserCam-HR-UV
Sensor Elements (pixels)	1280 x 1024	
Effective Pixel Resolution (µm)	–	20 x 20
Pixel Size (µm)	6.7 x 6.7	
Sensor Active Area (mm)(H x V)	8.5 x 6.8 (2/3 inch format)	
Spectral Range (nm)	300 to 1100 (without LDFP) 400 to 1100 (with LDFP included) 190 to 355 (with BIP-12F accessory)	190 to 355
Beam Diameters (mm)	0.2 to 6.0	0.5 to 6.0
Glassless Sensor	Low Distortion Face Plate is removable	
Low-Distortion Face Plate (LDFP, LDFP-UV)	Laser-grade ND filter, OD = 2.5 at 632.8 nm	UV-grade ND filter, OD = 3.0 at 248 nm
Electrical Interface	USB 2.0	
Capture Modes	Continuous (CW), pulsed	Continuous (CW), pulsed
Variable Exposure Time	1 msec to 1 sec, default at 10 msec	
Pulsed Mode Trigger Methods	Trigger In (TTL)	
Maximum Pulse Trigger in Rate (Hz)	100 (without averaging adjacent pulses)	
Maximum Frame Rate (FPS)		
Live video, no calculations	15	20
Capture with calculations	10	15
Damage Threshold	32 mJ/cm² (without LDFP) at 1064 nm	200 µJ/cm² (without LDFP-UV) at 248 nm
CW Saturation	40 mW/cm² (with LDFP) at 633 nm 16 µW/cm² (without LDFP) at 633 nm 800 mW/cm² (with LDFP) at 1064 nm 320 µW/cm² (without LDFP) at 1064 nm	90 mW/cm² (with LDFP-UV) at 248 nm 90 µW/cm² (without LDFP-UV) at 248 nm
Pulsed Saturation	8 mJ/cm² (with LDFP) at 1064 nm 3.2 µJ/cm² (without LDFP) at 1064 nm	5 mJ/cm² (with LDFP) at 248 nm 5 µJ/cm² (without LDFP) at 248 nm
USB 2.0 Cable	6 ft. standard A/B cable included	
Trigger Connector	BNC receptacle (trigger cable included)	
Part Number	1098577	1149004

[1] Order part number 1086828 for metric mount.

LaserCam-HR


27 2 mm (1 07 in)
41 0 mm (1 61 in)
Image Plane
17 9 mm (0 7 in)
74 3 mm (2 93 in)
9 2 mm (0 36 in)
1 4 20 UNC
68 1 mm (2 68 in)
68 1 mm (2 68 in)
79 3 mm (3 12 in)
Ø20 3 mm (0 8 in)
LDFP Adapter
Protect ve Cap
Rotat onal Mount[1]

LaserCam-HR-UV


27 2 mm (1 07 in)
41 8 mm (1 65 in)
Image Plane
18 7 mm (0 74 in)
74 3 mm (2 93 in)
9 9 mm (0 39 in)
1 4 20 UNC
68 1 mm (2 68 in)
68 1 mm (2 68 in)
79 3 mm (3 12 in)
Ø11 2 mm (0 44 in)
LDFP Adapter
Protect ve Cap
Rotat onal Mount[1]

Beam Diagnostic Cameras

LaserCam-HR-InGaAs

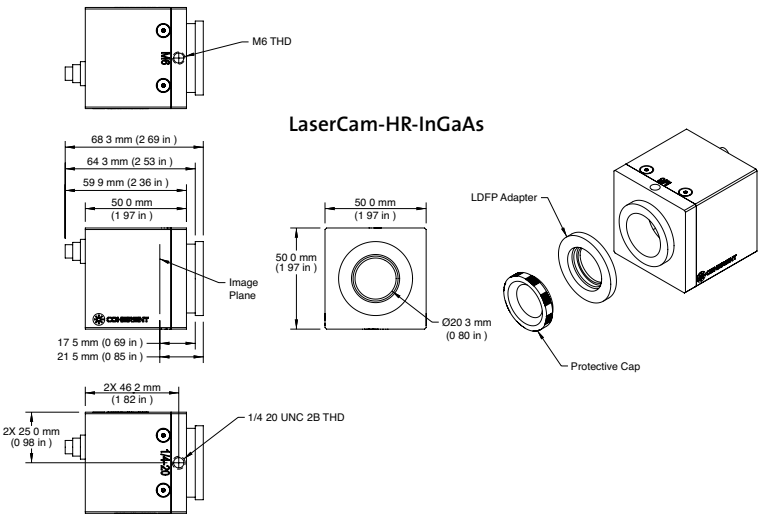
LaserCam-HR-InGaAs

Features

- USB 2.0 large-area, InGaAs sensor, 9.6 mm x 7.7 mm
- 14-bit digital output providing >1000:1 optical dynamic range
- Outstanding linearity error of <1%
- 30 µm x 30 µm pixel pitch
- Compact 50 x 50 x 68 mm package
- CW and pulsed operation including external triggering
- Coherent Adaptive Pixel Technology (CAPT) pixel-by-pixel offset, linearity and blemish correction
- Variable exposure time, 20 µsec to 25 msec
- User variable trigger delay
- C-mount thread for additional accessories

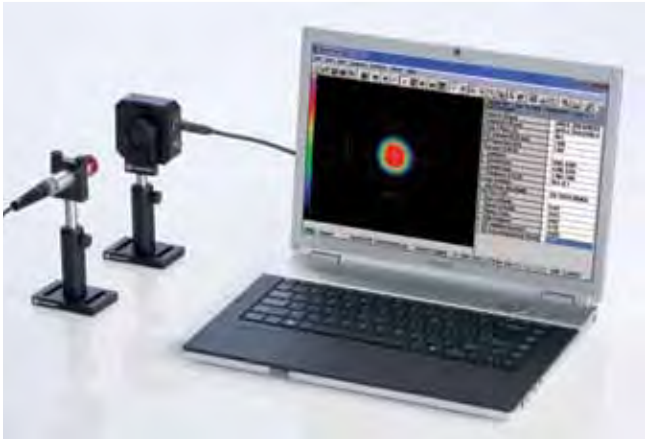
Device Specifications

Model	LaserCam-HR-InGaAs
Sensor Elements (pixels)	320 x 256
Pixel Size (µm)	30 x 30
Sensor Active Area (mm)(H x V)	9.6 x 7.7
Spectral Range (nm)	900 to 1700
Beam Diameters (mm)	0.5 to 6.0
Glassless Sensor	Low Distortion Face Plate is removable
Low-Distortion Face Plate (LDFP)	Laser-grade ND filter, OD = 2.5 at 632.8 nm
Electrical Interface	USB 2.0
Capture Modes	Continuous (CW), pulsed
Variable Exposure Time	20 µsec to 25 msec, default at 1 msec
Pulsed Mode Trigger Methods	Trigger In (TTL)
Maximum Frame Rate (FPS)	25 (live video, no calculations), 15 (capture with calculations)
Saturation	
CW (at 1064 nm)	3.5 mW/cm² (with LDFP), 50 µW/cm² (without LDFP)
CW (at 1523 nm)	350 µW/cm² (with LDFP), 30 µW/cm² (without LDFP)
Pulse (at 1064 nm)	5 µJ/cm² (with LDFP), 0.08 µJ/cm² (without LDFP)
USB 2.0 Cable	6 ft. standard A/B cable included
Trigger Connector	BNC receptacle (trigger cable included)
Part Number	1149002



BeamView Analyzer Software

Introduction to BeamView-USB Software



To monitor, analyze and archive laser beam images, BeamView Analyzer software is recognized as the leading laser beam profiling software. It has been designed to provide the maximum flexibility, speed, and user friendliness. Coherent offers two BeamView Analyzer software packages for maximum flexibility: BeamView Digital 3.2 is provided along with LaserCamIIID digital cameras. BeamView-USB 4.4 is included with all LaserCam-HR USB 2.0 cameras and provides additional new features.

Features

- **High-speed USB 2.0 camera interface (BV-USB software only)**
- **Supports all three LaserCam-HR camera types**
- **Remote control interface**
- **Over 30 numerical analysis functions**
- **Multiple image import and export formats**
- **Automatic background noise subtraction**
- **Pass/Fail fault settings, alarms, configurable setups**
- **Easy-to-use, intuitive user interface**
- **BeamView Digital: Windows XP only**
- **BeamView-USB: Windows XP, Vista 32-bit, Vista 64-bit (with LaserCam-HR and LaserCam-UV cameras only), Windows 7 32-bit, Windows 7 64-bit (with LaserCam-HR and LaserCam-UV cameras only). 64-bit compatibility was released in BeamView 4.4.2.**

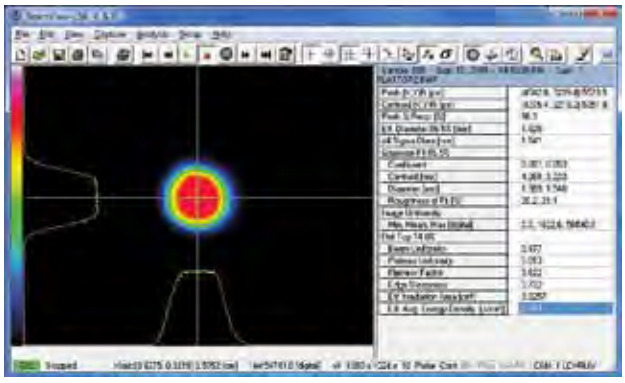
BeamView-USB Analyzer Software

BeamView-USB Analyzer Software
The latest release of the BeamView-USB 4.4 software includes several new features that extend the analytic capabilities of the LaserCam-HR laser beam diagnostic systems. These new features, not available with Analog or Digital BeamView Analyzer Software, include:

- Supports both 10-bit and 14-bit LaserCam-HR camera types
- Multiple LaserCam-HR camera types can be connected to a single system
- Flat-top beam analysis
- Adjustable trigger delay
- Report generation
- Variable exposure time
- LabVIEW drivers
- RS-232 and TCP/IP remote communication protocols

Flat-Top Beam Analysis
Six additional calculations are now available with BeamView-USB software for flat-top beam analysis. These calculations are based on the ISO 13694:2000 standards. The six calculations allow greater flexibility for the analysis of applications involving flat-top beam shapes. They also may assist in the analysis of beam uniformity of excimer and Nd:YAG lasers in the near field. The six new calculations are:

- Plateau Uniformity
- Flatness Factor
- Edge Steepness
- Beam Uniformity
- Effective Irradiation Area
- Effective Average Power/Energy Density



Screen shot of a flat-top beam image

Image of dialog box for flat-top calculations.

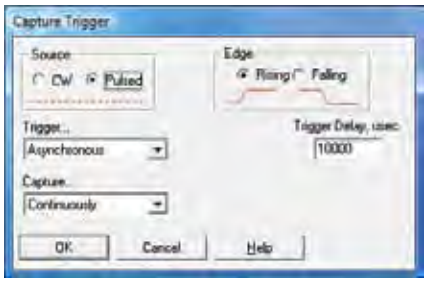
BeamView Analyzer Software

BeamView Analyzer Software Features

Adjustable Trigger Delay
A new adjustable Trigger Delay feature in the BeamView-USB 4.4 software lets users add default trigger delay to the LaserCam-HR camera. This assists by providing additional flexibility when firing the camera from an external trigger source such as the SYNC Output of a laser.

Adjustable Exposure Time
The camera exposure time is adjustable through the camera settings menu for all LaserCam-HR camera models.

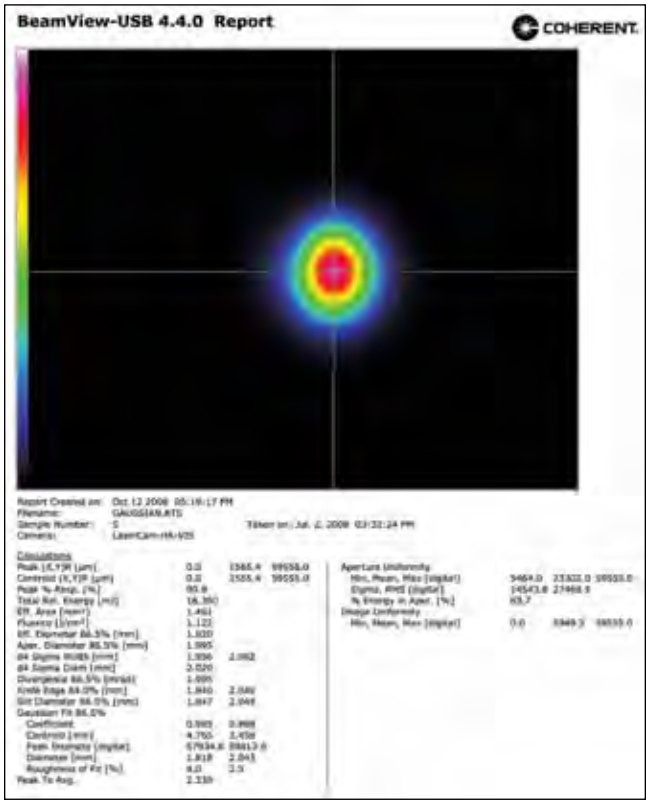
Report Generation
BeamView-USB includes a single-page report that can be sent directly to a printer, saved to a file (.txt), or converted to an Adobe .pdf file by using a pdf file converter. A simple screen print option is available from the same friendly dialog box used to generate a report.



Screen shot of Capture/Trigger dialog box showing Trigger Delay setting

BeamView System Performance Optimization

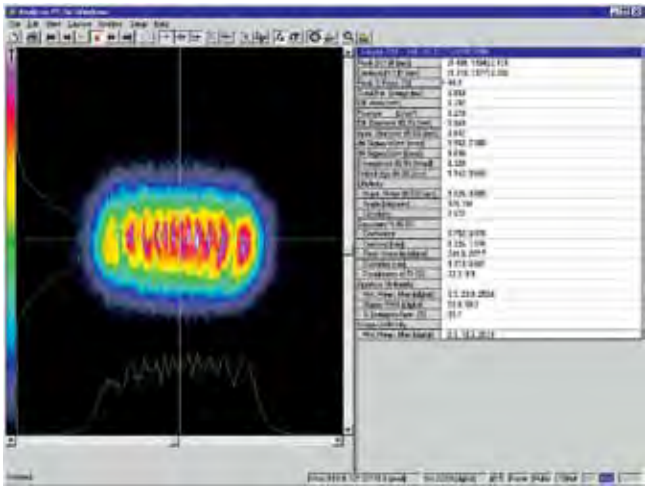
All BeamView Analyzer software provides several functions that optimize the optical dynamic range available in the camera to achieve maximum measurement accuracy. The Automatic Background subtraction feature measures and stores the background noise "image" and automatically subtracts individual pixel noise levels from all subsequent laser images prior to analysis. The system also automatically monitors the background noise level to warn of changes that may effect measurement accuracy.



Screen shot of Print Screen dialog box and actual report

BeamView Analyzer Software

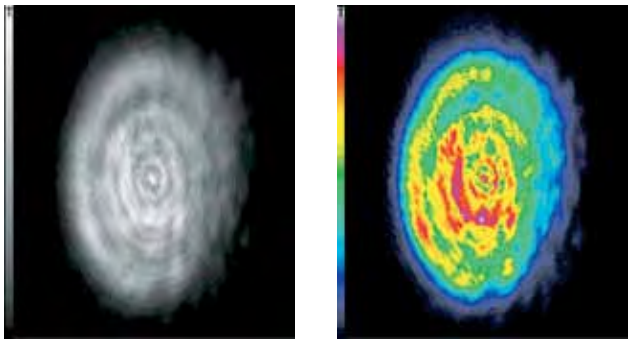
BeamView Analyzer Software Features



BeamView Analyzer Software Additional Features
The following BeamView Analyzer features are common among both BeamView software platforms:

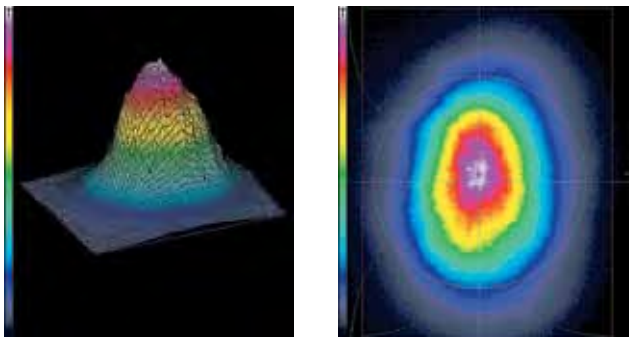
- **More than 25 different numerical analysis functions**
- **Several different profile views**
- **Multiple image import and export formats**
- **Import and export of results data and profile data**
- **Pass/Fail settings and user-selectable fault actions**

Real-Time Laser Monitoring and Alignment
The Live Video mode provides a continuously updated image of the beam (~20 Hz to 25 Hz, depending on the speed of the processor) displayed in shades of gray or pseudo-color. This mode is ideal for monitoring the laser and observing changes in the form and structure of the beam as it is adjusted. It also allows for real-time tuning to achieve optimum beam profile quality and laser-cavity alignment. While operating in this mode, no beam or statistical data are displayed, but if Run is activated, the image is stored and can be analyzed later.

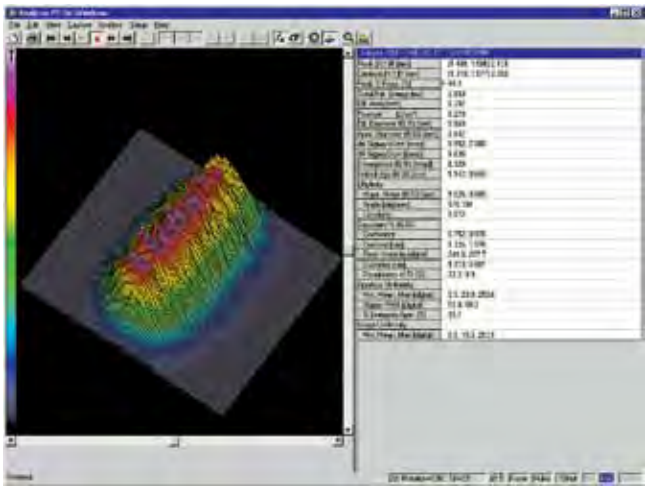


The Live Video mode

2D and 3D Intensity Plots
The Run command switches the BeamView Analyzer from the Stop or Live Video mode to continuous operation, which provides capture, analysis and display of beam image data. The view area of the computer monitor provides a choice of 2D or 3D images. The 2D contour maps and the 3D isometric plots display laser beam intensity profiles in a choice of color and gray-scale styles (fixed and autoscaling to a peak) and sizes (continuous zoom and pan control). The 2D maps can be shown with or without profiles (and Gaussian fit), reference position, variable aperture and rotatable crosshairs (with auto peak and auto centroid location). The 3D isometric plots can be displayed with transparent, hidden or solid wires, and can be rotated and viewed from different tilt angles.



Choice of 3D and 2D images



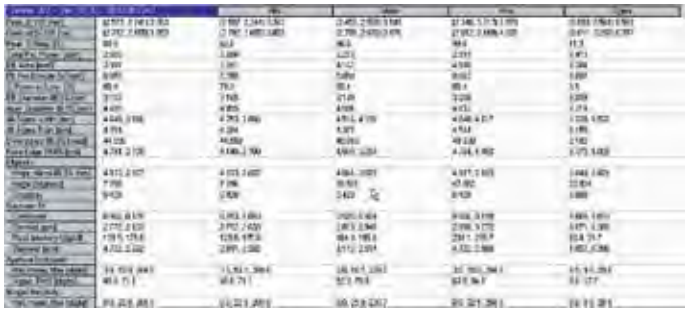
BeamView Analyzer display with 3D image and ISO-compatible results

BeamView Analyzer Software

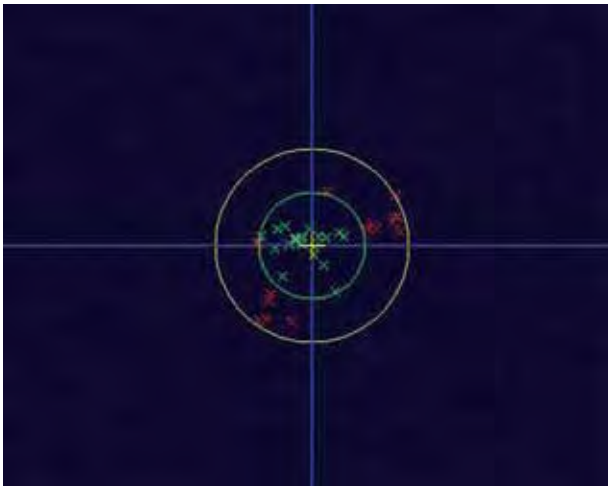
BeamView Analyzer Software Features

Beam Stability

The continuous on-line statistical analysis display shows results of all, or a combination of, functions and pass/fail parameters for all captured samples and accumulated results. The user can scroll through the analysis results of individual images, and also view the minimum, maximum and sigma (standard deviation) values. This makes comparing individual samples to the time-dependent statistical data easy. Thus, the jitter and stability of parameters, such as power, energy, pointing direction, ellipticity and beam size, etc., can be analyzed simultaneously with a polar beam wander plot.



Continuous on-line statistical analysis display

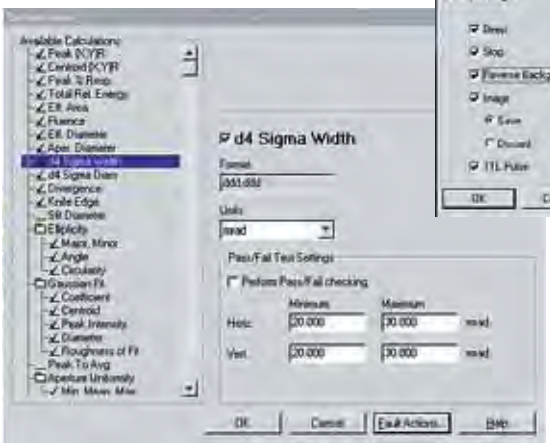


Polar beam wander plot screen

Pass/Fail Analysis

Pass/fail analysis allows simultaneous real-time monitoring of all, or any one of the analysis results against user-specified minimum/maximum limits. Any combination of, or all the fault actions can be activated to signal a test failure, initiate a visual alarm, an audio alarm, stop data capture, reject/save a failed sample, and generation of a TTL trigger pulse output signal.

Fault Actions Dialog Box



Calculations Pass/Fail test settings

Remote Control

The BeamView Analyzer provides remote control and data transfer through the host computer's RS-232 (and TCP/IP with BeamView-USB). A complete control and data transfer command set is provided to allow users to develop their own remote control application for interfacing with the BeamView Analyzer software platform. The BeamView-USB software package includes a full suite of LabVIEW libraries for remote access to most BeamView features at a host computer running LabVIEW.

Beam Analysis and Statistics

BeamView Analyzer software calculations are compatible with the International Standards Organization (ISO) guidelines for laser beam measurement:

- Peak and centroid beam position
- Beam ellipticity including angular position and major/minor axis information
- Circularity
- D4σ diameters and widths
- Guassian fit including coefficient, centroid, and "roughness of fit"
- Aperture fit and uniformity
- Total/relative power
- Peak power/energy density
- Percent power within an aperture

The BeamView analyzer system also includes several other analysis features listed in the BeamView Analyzer Software Features Summary on page 80.

BeamView Analyzer Software

BeamView Analyzer Software Features Summary

Analysis, On-Line Pass/Fail Tests

- **Centroid position/wander**
- **Peak intensity/position**
- **Peak-to-average intensity**
- **Beam diameter/widths (selectable):**
  - Second moment (δ4 Sigma)
  - Knife-edge
  - Slit
  - Aperture diameter
  - Effective diameter
- **Flat Top analysis (new in BeamView-USB 4.4):**
  - Beam uniformity
  - Plateau uniformity
  - Flatness factor
  - Effective irradiation area
  - Edge steepness
  - Effective average power/energy Density
- **Gaussian fits with:**
  - Correlation coefficient
  - Diameter
  - Centroid
  - Peak intensity
  - Fit roughness
- **Ellipticity at intensity slice:**
  - Major and minor axis diameter
  - Circularity (major/minor)
  - Axis orientation (rotation)
  - Auto align profiles to axis
- **Aperture analysis for circular, square, rectangular and elliptical beams:**
  - % power/energy in aperture
  - Uniformity in aperture
  - Aperture/diameter tracking
- **Selectable calculation area**
- **On-line statistical analysis (all results):**
  - Minimum, average, maximum
  - Sigma (standard deviation)
- **Pass/Fail test with fault action (all results):**
  - Ratio
  - Audio/visual alarms
  - Save/reject images
  - TTL pulse out
  - Stop data capture
- **Image averaging**
- **Peak energy/power density**
- **Relative energy/power**
- **Effective area**
- **Divergence at % energy/power**

Interactive Display Functions

- **On-line help**
- **Report generation (new in BeamView-USB 4.4):**
  - Report (.pdf)
  - BeamView window (screen capture)
- **Stored image paging**
- **Reference profile select**
- **Reference coordinate set**
- **Background subtraction**
- **Run/stop data analysis**
- **Control of cursors, profiles, aperture, position, rotation and size**
- **Live video on/off**
- **7 zoom levels**
- **Image and profile autoscale modes**
- **Auto peak/centroid locate**
- **A/D converter control (analog only)**
- **"Hot" function keys**

BeamView Analyzer Software

BeamView Analyzer Software Features Summary

Image Capture and Storage

- **Pulsed or CW (continuous) analysis**
- **Multi-channel (not simultaneous) camera input**
- **Support for multiple camera types (new in BeamView-USB 4.4)**
- **Adjustable camera exposure time (new in BeamView-USB 4.4)**
- **Image storage to:**
  - PC RAM drive
  - PC hard drive
- **RS-232 and TCP/IP communication protocols**
- **Comprehensive suite of LabVIEW libraries**
- **Multiple trigger modes:**
  - External (asynchronous, trigger input)
  - Autotrigger to a selected level
  - Synchronous (trigger output, BeamView Digital and Analog software only)
- **3 resolution modes with BeamVIew-USB 4.4 with the LaserCam-HR and LaserCam-HR-UV cameras:**
  - 1280 x 1024 x 10
  - 640 x 512 x 10
  - 640 x 512 x 8
- **1 resolution mode with BeamView-USB 4.4 with the LaserCam-HR-InGaAs camera:**
  - 320 x 256 x 14
- **3 resolution modes with BeamView Digital:**
  - Frame (752 x 480 pixels)
  - Full-Field (376 x 240 pixels)
  - Half-Field (188 x 120 pixels)
- **Various capture modes:**
  - Continuous
  - Time interval
  - On command (keypress)
- **High-speed sample mode capture**
- **Profile storage**
- **Configuration storage with password protection**
- **Image data file formats in binary (bin), ASCII (img), bmp, jpg, png, tif**

Calibration Functions

- **Fully automatic background map correction (pixel-by-pixel) with bias offset**
- **Automatic background monitor and warning**
- **Automatic A/D offset/gain set (analog only)**
- **Optical scale factor (magnification/reduction)**
- **Far-field optic focal length**
- **Camera pixel size (horiz. and vert.) (analog only)**
- **Power/energy calibration factor**

Standard Graphics Feature

- **Contour map with profiles/aperture overlay:**
  - 3 plot types (contour/2D, 3D, Polar)
  - 4 scaling levels (fixed, scale-to-peak, low intensity, high intensity)
  - 4 style settings (gray, smooth, sharp, shaded bands)
- **Live video mode**
- **Calculation inclusion area display**
- **Profile/peak/centroid position cursor**
- **Graphic zoom**
- **Auto-scale 2D or profile intensity**
- **Polar beam wander plot**
- **On/off axis simultaneous display of:**
  - Position cursor
  - Cross-section profiles
  - Gaussian fit profiles
  - Reference profiles
  - Aperture overlay for:
    - Beam uniformity
    - % energy/power
- **Rotatable color 3D isometric plot**
  - 360°, 90° rotate/tilt
  - Hidden/transparent wire
  - Selectable wire density
  - Solid or single color
  - Auto-rotate mode

Beam Diagnostic Accessories

Laser-Grade Attenuation Optics for Cameras

Attenuation Optics and Accessories

Features

- **Laser-grade attenuation optics**
- **Compatible with all Coherent beam diagnostic cameras**
- **Virtually undistorted and interference-free attenuation**
- **Variable and fixed attenuation for beams up to 2000W/cm² or 50J/cm²**
- **C-Mount threads couple directly to cameras**

Most cameras are too sensitive for direct viewing of laser beams. For example, a typical diagnostics camera saturates at only ~0.5 µW/cm² power density (at ~633 nm) or at ~9 nJ/cm² (at 1064 nm) pulsed energy density. If the camera has an electronic shutter, it can be used for some CW beam attenuation, but there is more flexibility in using optical attenuation. Any attenuation optics introduced in the beam path must be manufactured to exacting specifications. The optics must be laser-grade substrate, and use the proper flatness and wedge to avoid etaloning and fringing, so that the beam is not distorted by the introduction of the attenuation. We offer attenuation optics that are designed to these specifications and packaged for use with our cameras.

Typical attenuations are 1:1 to 400,000:1, but even larger attenuations are possible. All Coherent diagnostic cameras accept C-Mount optics and accessories, and are delivered without a standard window in front of the sensor array. Such windows are liable to distort the optical beam. However, a LDFP (Low-Distortion Face Plate) filter is supplied with each camera purchased from Coherent. The LDFP is a laser-grade optic specified and polished for diagnostics use. It is mounted in a housing with C-Mount threads and provides attenuation of room light so that the camera can be used with the lights on. For operation below 400 nm, the LDFP must be removed.

The Continuously Variable Attenuator Modules (C-VARM and UV C-VARM) contain two wedge attenuators that are continuously variable and a step attenuator that allows attenuation from 10^7:1 down to 3000:1. The C-VARM and UV C-VARM can be finely adjusted to achieve both precise attenuation levels and maximum use of the camera's optical dynamic range.

The Variable Attenuator Module (VARM) is a triple-wheel filter holder that contains three filters per wheel. The filters are made to our exacting specifications for transmission value and material quality. The VARM is adjustable in attenuation in 64 discrete steps of approximately 16% reduction each time from 400,000:1 down to 1:1. The VARM can be easily returned to exactly the same attenuation level as previously used.

The BeamCUBE Fixed-Attenuator Modules (BCUBE and UV-BCUBE) provide fixed attenuation and beam pickoff for performing diagnostics on high-power laser sources. The BCUBE and UV-BCUBE utilize the front surface reflection from an uncoated laser mirror to achieve beam samples at 2% to 10% of the incident radiation, depending upon beam polarization. Multiple BCUBEs can be coupled together for even higher fixed attenuation levels.

Beam Diagnostic Accessories

Attenuation Optics for Cameras

BCUBE, UV-BCUBE, VARM, C-VARM, UV C-VARM and all other Coherent cameras have female C-Mount threading, making them easy to connect with the male C-Mount connection flange provided with each attenuator. Also, all attenuators have 1/4-20 tapped holes for independent post or plate mounting.

The C-Mount flanges (threaded rings) also have a female RMS microscope thread. This allows a microscope objective to be coupled to the attenuators and extension barrels in order to create a flexible close-up imaging system for analysis of small/focused beams, fiber optics, laser diodes or LEDs.

VARM, LaserCam-HR-InGaAs, C-VARM, BCUBE, C-Mount Flanges and Barrel

Avoiding Multi-Filter Beam Distortion

The wavefront distortion through a number of optical filters can be calculated by taking the square root of the sum of the squares of the wavefront distortion of the individual components. For example, if the individual optics are made to λ/10 specifications and six are used, a total λ/4 RMS wavefront distortion will be introduced to the beam:

$$\sqrt{0.1^2 + 0.1^2 + 0.1^2 + 0.1^2 + 0.1^2 + 0.1^2} = 0.25$$

In general, a camera cannot sense less than ~λ/4 total distortion in the beam, so if a series of filters is used, they must be made to very exacting laser-grade specifications. Attenuating optics from Coherent are manufactured to better than a λ/10 surface specification, so at least six optics in series can be used. Calculate the Low-Distortion Face Plate (LDFP) and each BCUBE as one optic, and the VARM or C-VARM as three optics each.

Attenuator Selection

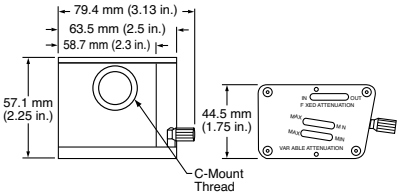
Attenuation is selected on the basis of power density in W/cm² or energy density in J/cm². The attenuation from the camera's Low-Distortion Face Plate (LDFP) will allow an average power density of up to 1.2 mW/cm². There are then only two more steps to attenuation selection:

1) Choose either the VARM or the C-VARM for up to 1W/cm².
2) In addition or alternatively, use a BCUBE beamsplitter module to pick off between 2% and 10% of the beam (depending on polarization and wavelength).

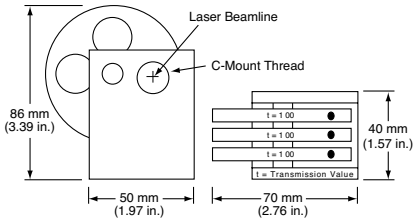
Device Specifications	Model	VARM	C-VARM	UV C-VARM	BCUBE	UV-BCUBE	BARREL SET (Barrels, 3 C-Mount Flanges)
Wavelength							
	Min. (nm)	380	380	190	380	190	–
	Max. (nm)	2200	2200	1100	2200	2200	–
Attenuation							
	From	4×10^5:1	10^7:1	10^5:1	50:1	50:1	–
	To	1:1	3000:1	300:1	10:1	10:1	–
Aperture (mm)		19	17	17	19	19	–
Max. Power Density (W/cm²)		1*	1*	1*	2.0×10^9	2.0×10^9	–
Max. Energy Density (J/cm²)		0.1*	0.1*	0.008	50	50	–
Damage Limit							
	(W/cm²)	5×10^7	5×10^7	–	2.5×10^9	2.5×10^9	–
	(J/cm²)	10	10	0.008	50	50	–
Beam Offset (mm)		–	–	–	4.0	4.0	–
Part Number		33-3328-000	33-3336-000	33-6859-000	1098403	1098466	1098426

* The maximum power and energy density listed are the levels at which thermal lensing occurs.

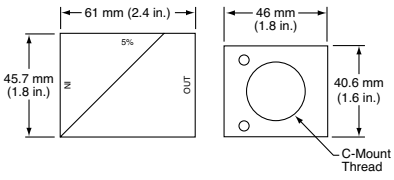
C-VARM and UV C-VARM



VARM



BCUBE and UV-BCUBE



Beam Diagnostic Accessories

Extreme-UV Beam Intensity Profiler (BIP) Optics

BIP-5000Z and BIP-12F attached to a LaserCam-HR

BIP-5000SPL Beamsplitter

Features

- **UV operation from 10 nm to 355 nm**
- **Choice of 12 mm or 30 x 40 mm diameter apertures**
- **Operation with BeamView Analyzer Systems**

These Extreme-UV Beam Profiler Optics use UV-to-visible fluorescence converter face plates to couple the input laser beam to any appropriate Coherent camera. Any of our visible wavelength range cameras can be used with the Beam Intensity Profilers.

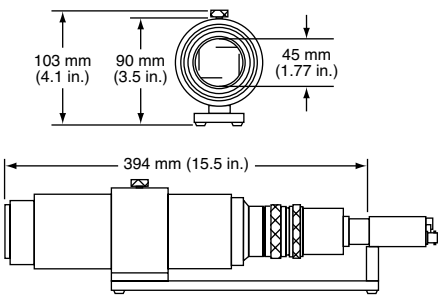
The Beam Intensity Profiler BIP-12F is a compact system accepting beams up to 12 mm in diameter from 10 nm to 355 nm. The front of the BIP-12F has a C-Mount thread, which allows it to be used in conjunction with the UV BeamCube when high-power attenuation is needed for the spectral region 190 nm to 355 nm (see Laser-Grade Attenuation Optics for Cameras on page 82). The Beam Intensity Profiler BIP-5000Z has a zoom magnification range of 6:1 to 1:1 and accepts beams up to 30 mm by 40 mm from 10 nm to 320 nm. It comes with the mount shown.

BIP-5000SPL Beamsplitter
When laser beam power or energy density exceeds recommended ranges, this beamsplitter provides additional high-power attenuation capability for the BIP-5000Z. It provides a right-angle pick-off function and attaches to the entrance aperture of the BIP-5000Z.

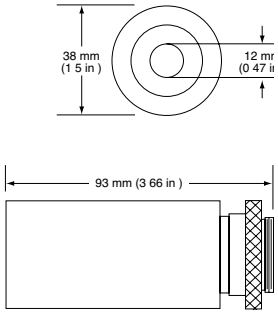
Device Specifications

Model	BIP-12F (2:1)	BIP-12F (1:1)	BIP-5000Z	BIP-5000SPL
Wavelength (nm)	10 to 355		10 to 320	10 to 320
Aperture (mm)	Ø12		30 x 40	Ø50
Resolution (camera-dependent)(µm)	20		70	–
Saturation				
at 193 to 248 nm	10 mJ/cm²		30 mJ/cm²	–
at 308 nm	50 mJ/cm²		50 mJ/cm2	–
Sensitivity	5 µJ/cm²		5 µJ/cm²	–
Damage Threshold				
CW	5W/cm²		1.5W/cm²	10W/cm²
Pulsed	500 mJ/cm²		600 mJ/cm²	50 J/cm²
Uniformity Over Aperture (%)	5			–
Image Persistence (fluorescence lifetime)	500 ns		5 µs	–
Image Magnification	2:1	1:1	6:1(Zoom) to 1:1	–
Part Number	33-3468-000	1053418	33-3484-000	33-3492-000

BIP-5000Z



BIP-12F



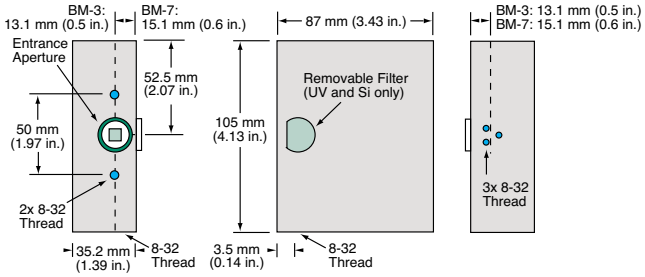
BeamMaster

Knife-Edge Beam Profiler

BeamMaster System (rotational mount shown is an option and is not included)

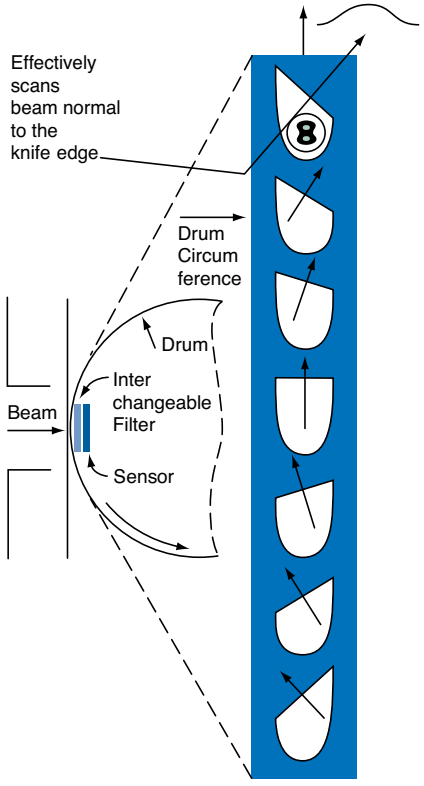
Features

- CW laser beam shape, power and position measurements
- Beam sizes from 3 µm to 9 mm with 0.1 µm resolution and high dynamic range
- Real-time Windows display, analysis and data logging system
- Wavelengths from 190 nm to 1800 nm



BeamMaster is a high-precision, multiple knife-edge scanning laser beam profiler which can be configured to sample, measure and display cross-sectional profiles and/or 2D and 3D image plots in real time up to 5 Hz. Selectable averaging of 1 to 20 samples provides noise reduction and maximizes measurement accuracy. Data can be collected, displayed, stored and continuously streamed to the RS-232 port. All screen images can be captured and stored, or be printed to any Windows-supported printer.

BeamMaster can measure focused beam spots as small as 3 µm with 0.1 µm resolution and has an aperture as large as 9 mm with 1 µm resolution for larger beams. Measurements can be made from 190 nm to 1100 nm (Si-Enhanced) and from 800 nm to 1800 nm (InGaAs). Input powers can be as low as 10 µW. There is automatic gain control and two internal distortion-free optical attenuation filters are included (Si-Enhanced models)

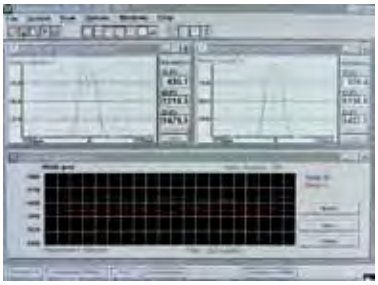


Multiple Knife-Edges for Greater Resolution and Accuracy
BeamMaster is an advancement over the more common types of beam profilers, which use two orthogonal knife-edges or slits to scan the beam profile. The BeamMaster model BM-7 uses seven individual knife-edges on a rotating drum to scan the beam through seven different axes in a single rotation. This provides more accurate measurements of the true beam shape and dimensions by tomographically combining the data from all seven scans to reconstruct a profile of the beam. This technique also makes locating the angular orientation of elliptical beam major/minor axes much easier than searching by rotating the sensor head around the optical beam axis. For applications with circular or near-Gaussian beams, the lower-cost BM-3, with only three knife-edges, is also available.

BeamMaster

Knife-Edge Beam Profiler

Beam Profiles and Widths



On each rotation of the drum, BeamMaster captures and processes the data from the passage of the seven knife edges across the beam (three knife edges with BM-3) as power, position and profile information. This information can be displayed every rotation, be strip-charted, and be sent to file or to the RS-232 port. Two orthogonal profiles can be displayed and the beam widths can be digitally displayed for any three user-chosen clip levels. A Gaussian-fit profile can be overlaid on any chosen measured profile and the fit and correlation parameters can be displayed.

To obtain the maximum profile detail, the system automatically centers the profile and zooms to display ~3 times the beam width, and the profile intensity data is autoscaled (optional) to fit the display height. Added detail can be obtained in a special high-resolution mode. This mode is very useful for analyzing beams that are either far from Gaussian in shape or smaller than 100 µm.

Beam Position and Ellipticity

The beam centroid position can be continuously monitored relative to the center of the sensor area, along with the beam shape, ellipticity (major and minor axes) and angular orientation. A zoom function is available and the user can choose the clip level and strip-chart the position (X and Y) data to monitor short-term or long-term, time-dependent stability or drift.

Power Measurement

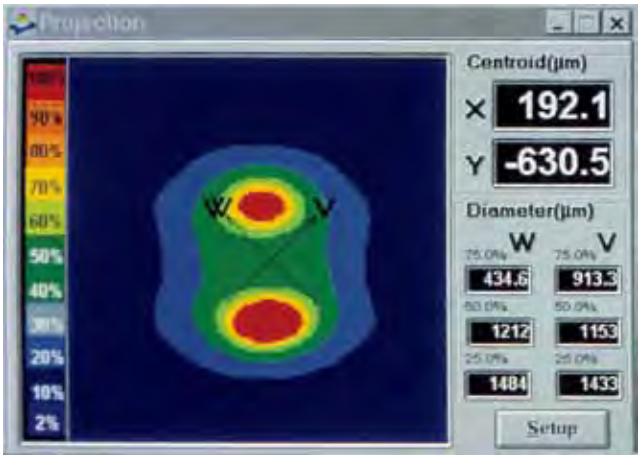
The beam power can be displayed either as a digital readout or in combination with an analog "needle." Units can be chosen as µW, mW or dBm, and the user can offset the zero and zoom in on any part of the power range. Attenuator (filter) files can be selected, and a test range can be selected and displayed to monitor beam power within specific limits, with optional audio alarms.

Data Collecting and QA Testing

Data regarding beam size, position and power can be continuously displayed in analog, digital and strip chart forms on the computer screen. Data can also be logged to a data file in real time for later processing or test report generation. Pass/Fail testing can be performed on measured results for acceptance within specific tolerances. Files can be transferred to another computer with an RS-232 link or data can be transferred in real time. All screen images also can be captured and stored as BMP or JPG files or can be printed to any Windows printer.

2D and 3D Intensity Plots

The projection function provides either a 2D or 3D view of the beam intensity profile. The projection is created using reconstructive tomography. The same method is used to produce 3D images with X-ray systems. The more knife edges, the greater the level of detail that can be obtained. For a beam distribution that is significantly non-Gaussian, such as that from a diode laser, the standard seven-knife-edge system can reconstruct a plot that closely matches the real beam. When examining near-Gaussian beams, the three-knife-edge system gives an accurate intensity distribution.



BeamMaster 2D Intensity Plot

BeamMaster

BeamMaster Accessories

The 2D contour maps and the 3D isometric plots can be displayed with or without scan axis and grids, and the isometric plots can be rotated for easier viewing of the detailed structure.

BeamMaster System Components

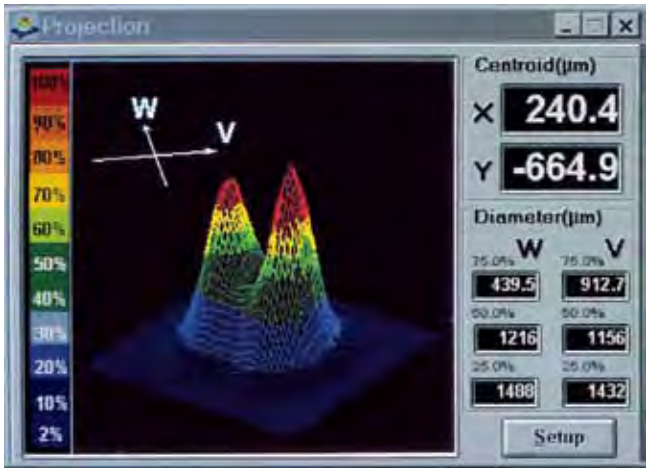
Each BeamMaster system consists of a sensor head, complete with a 1.8 m cable, a 1/2-length (187 mm) 32-bit PCI card to plug into a PC computer, complete Windows software on a CD-ROM disk, a printed instruction manual, a 0.5" mounting post (threaded 8-32), and optical filters (for Si-Enhanced).

Optical Filters

The BM-7 and BM-3 Si-Enhanced heads come with two neutral density filters. NG4 and NG9 filters (complete with transmission curves) are provided to extend the power range of the heads from 5 mW to 1W in the 400 nm to 1100 nm range. The NG4 filter comes pre-installed and provides ~10% transmission at 633 nm. The NG9 filter is in a protective filter case and provides ~0.5% transmission at 633 nm. There is no filter in the BeamMaster InGaAs head configurations.

Computer Requirements

The user provides a Pentium PC (586 or higher, 233 MHz) operating Windows 2000 or XP with a free PCI card slot. The system should have 32 megabytes of RAM, a CD-ROM drive, ~20 megabytes of free hard-disk memory, and a display resolution of 800 x 600 or higher.



BeamMaster 2D Intensity Plot

BeamMaster Accessories

An optional mount is available to enable rotation of the BeamMaster sensor head about the optical axis. This mount has a 360-degree calibrated scale with a locking screw. An optional C-Mount Adapter Plate allows the attachment of any C-Mount, threaded optical accessory, such as a BCUBE high-power attenuator pickoff optic (see the Beam Diagnostics Accessories section on page 82).

Device Specifications

Model	BeamMaster
Measurement Rate (Hz)	5
Wavelength Range (nm)	190 to 1100 [BM-7 Si-Enhanced, BM-3 Si-Enhanced] 800 to 1800 [BM-7 InGaAs (3 or 5 mm), BM-3 InGaAs (3 mm)]
Sensor Aperture	9 mm square [BM-7 (Si-Enhanced)] 5 mm circular [BM-3 (Si-Enhanced)] 3 mm circular [BM-3 and BM-7 (InGaAs)] (optional BM-7 InGaAs 5 mm available)
Minimum Beam Size (µm)	15 (BM-7 all models) 3 (BM-3 all models)
Beam Size Resolution	1 µm for beams >100 µm in size (0.1 µm for beams <100 µm in size)
Position Measurement Resolution (µm)	1
Position Measurement Accuracy (µm)	±15
Beam Width Measurement Accuracy (%)	±2
Beam Power Range	10 µW to 1 W (with supplied internal filters), saturation 0.1 W/cm² without filter, 20W/cm² with NG9 filter [BM-7, BM-3 (Si-Enhanced)] 10 µW to 5 mW (no filters provided), saturation 0.1 W/cm² [BM-3 InGaAs, BM-7 InGaAs]
Relative Power Measurement	0.1 µW resolution
Sensor Head Weight (g)	56 g
Part Number	
1037702	BeamMaster BM-7 Si-Enhanced
1037699	BeamMaster BM-3 Si-Enhanced
1037710	BeamMaster Bm-7 InGaAs (3 mm)
1037712	BeamMaster BM-7 InGaAs (5 mm)
1037708	BeamMaster BM-3 InGaAs (3 mm)
1038024	BeamMaster Rotation Mount
33-7147-000	BeamMaster C-Mount Adapter Plate
1037713	BeamMaster PCI Upgrade Kit

ModeMaster PC

M^2 Beam Propagation Analyzer

Features

- **Measurement and display of CW laser divergence, M^2 (or k) and astigmatism**
- **Beam sizes 0.2 mm to 25 mm**
- **Wavelengths from 220 nm to 15 µm**
- **Determination of waist location and diameters (including D4σ diameter) and Rayleigh range**
- **Angular and translational beam-pointing stability**

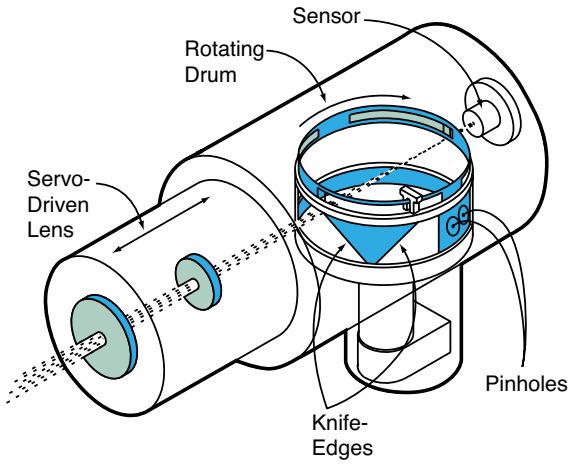
How Does the ModeMaster PC Work?

The ModeMaster PC head is a dual-knife-edge beam profiler integrated with a diffraction-limited precision scanning lens, which is translated along the beam propagation axis. The lens focuses the beam to create an internal beam waist, and the two orthogonal knife edges (X and Y), which are mounted on a rotating drum, measure the beam diameter and beam axis location at 256 planes along the beam waist as the lens is translated. The powerful ModeMaster PC software then derives the M^2 factor, the size and location of the beam waist, the far-field divergence angle, the pointing direction, astigmatism and asymmetry, and the Rayleigh range.

Measurements also include ISO D4σ, second moment, knife-edge, slit and D86 beam diameters. The entire measuring process occurs in less than 30 seconds.

The ModeMaster PC also provides special weighting functions to help eliminate effects on measurement accuracy due to intermittent beam noise, vignetting or other transients during the focus scan. Real-time displays allow laser peaking or adjustment for minimum M^2, divergence, maximum power density, far-field pinhole profiles and pointing angle.

Complete Geometric Beam Characterization Along the Laser Beam Path

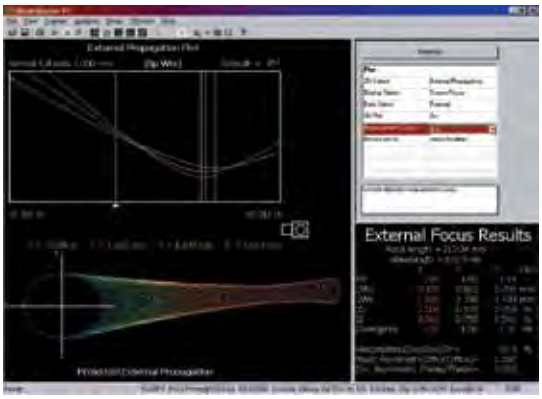


- **Beam Quality – M^2**
- **Beam Diameter**
- **Waist Diameter & Location**
- **Divergence Angle**
- **Rayleigh Range**
- **Pointing Stability**
- **Power Density**
- **Beam Profiles**
- **Second-Moment Diameters**
- **Astigmatism**
- **Waist Asymmetry**
- **Divergence Asymmetry**

Beam propagation is concerned with the energy distribution in a beam and the change of that distribution along the beam path. The ModeMaster Beam Propagation Analyzer established a new laser beam quality parameter, M^2, which has now become an ISO measurement standard. M^2 describes how close to "perfect-Gaussian" a laser beam is, and can be used to predict the beam size, beam shape and the smallest spot that can be created from the beam further downrange.

ModeMaster PC

M^2 Beam Propagation Analyzer



Beam Propagation Display

Coherent pioneered M^2 beam propagation analysis with the ModeMaster system a decade ago. Now, the new ModeMaster PC Laser Beam Propagation Analyzer combines all the ISO-compliant accuracy and powerful features needed for measuring M^2 and other beam propagation analysis functions for CW lasers. It also provides the added flexibility and value of a personal computer to provide optimum user control, data processing, storage and results display.

The ModeMaster PC includes a Universal Serial Bus (USB) control/interface console and Windows software for operation with Windows 2000 or XP). The ModeMaster PC is also compatible with all existing ModeMaster systems, allowing legacy ModeMaster system users to easily upgrade their systems for use on a supported PC computer.

Easy Beam Alignment

The precision 5-axis head mount and beam position display of the ModeMaster PC provide easy angular alignment and translational centering of the lens and scan axis to the beam propagation path.

Second-Moment Diameters

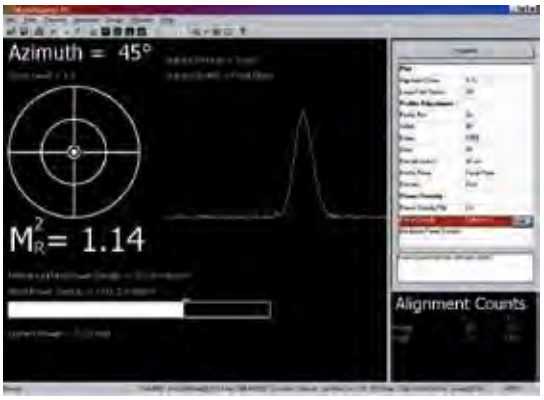
Beam diameter is a critical parameter in beam propagation measurements. Second-moment diameters ($D4\sigma$) give the best theoretical answers for beam propagation calculations. The ModeMaster PC measures second-moment diameters directly. The ModeMaster PC software also includes conversion algorithms from its knife-edge measurements to second-moment diameter measurements that are valid for stable resonator modes with M^2 of 1 to 4 (covering most commercially available lasers). Also included are conversions to D86 and slit diameters to allow comparison to other measurements.

Real-Time Power Density Adjustment

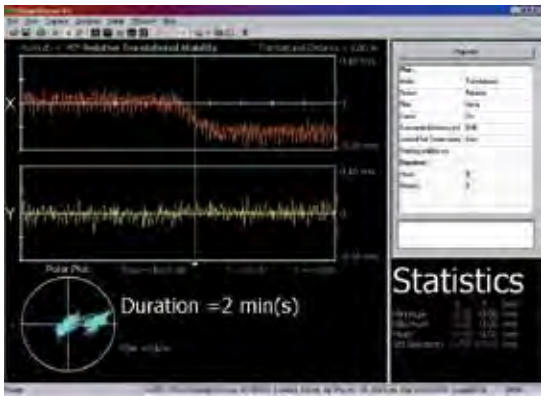
In most laser applications it is not laser power that does the work but power density. Using the ModeMaster PC, the point of maximum power density can be quickly located. A convenient power density tuning screen displays power density as a pseudo-analog "tune bar," giving real-time feedback as the laser mirrors are adjusted.

ModeMaster PC

M² Beam Propagation Analyzer



Real-Time Display



Pointing-Stability Display

Real-Time M² and Beam Profiles
The ModeMaster PC provides real-time measurement and display for fine tuning M² and many other beam propagation parameters, as well as the near-field or far-field pinhole intensity beam profiles.

Beam-Pointing and Translational Stability
ModeMaster is able to measure and display both translational (parallel to the beam axis) or angular (from a pivot point) beam movement over a period of 2 minutes to 24 hours. The angular pivot point of the beam axis (often a single optical surface) can be located along the beam path. Statistical analysis of the beam axis location and angle are displayed for both the X and Y axes. Three levels of filtering reduce noise and increase the sensitivity of pointing-stability measurements.

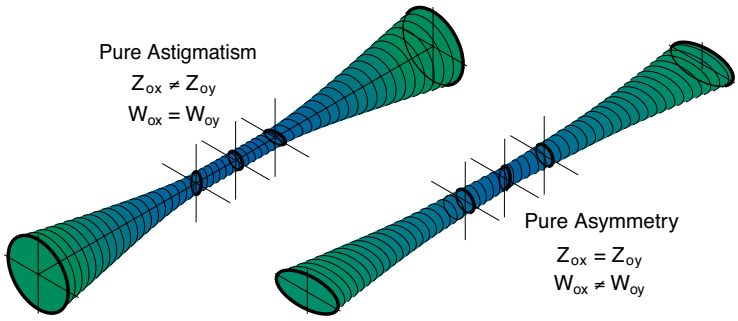
Expanded Online Help
The ModeMaster PC provides complete online help. Help messages also suggest corrective measures when beam parameter limits are exceeded.

Upgrading to the ModeMaster PC
All previous versions of the ModeMaster systems can be upgraded to the ModeMaster PC. The original console unit and the LabMaster display are simply replaced with the ModeMaster PC Control/Interface Module and Software, installed in a user-supplied compatible PC computer. All original ModeMaster scan heads are fully compatible and can be plugged into the ModeMaster PC Control/Interface Module, which can be ordered separately with the software.

RS-232 Interface
The ModeMaster PC can provide measured beam data, analysis results and focus scan control (through the RS-232 interface) for remote data logging, results monitoring and measurement control.

Beam Astigmatism and Asymmetry

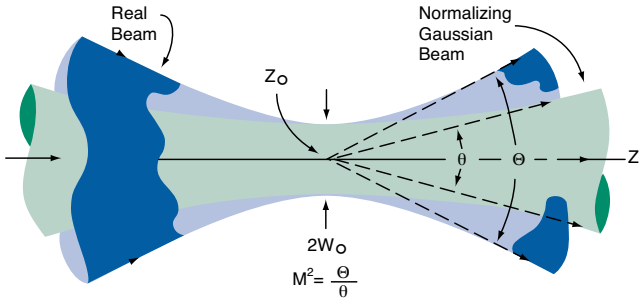
Changes in the shape of a propagating beam can be astigmatic, asymmetric or both. The beam shown at the near right has pure astigmatism; the waists (Wo) in the horizontal and vertical directions are the same size, but occur at different propagation distances (Zo). In asymmetric beams (far right) the two waists occur together, but are of different diameters. The ModeMaster PC provides complete analysis of these beam characteristics.



ModeMaster PC

Laser Beam Quality

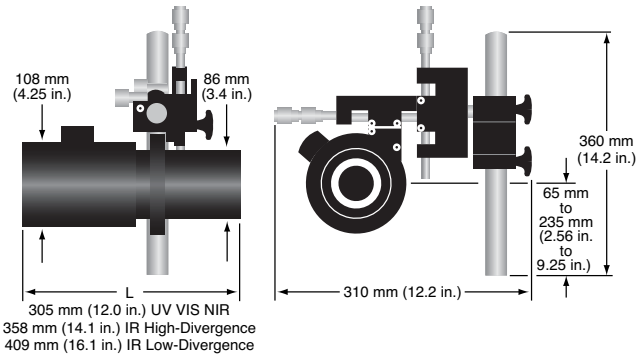
The closer an actual laser beam is to diffraction-limited, the more tightly it can be focused, the greater its depth of field, and the smaller the diameter of the beam optics can be to transmit the beam. M^2 is the ratio of the divergence of the actual beam to that of a theoretical diffraction-limited beam of the same waist size in the TEM_{00} mode. Thus, the angular size of the beam in the far field will be M^2 larger than calculated for a perfect Gaussian beam.



$\Theta = M^2 \times 2\lambda / (\pi W_o)$, FOR A BEAM WAIST DIAMETER $2W_o$.

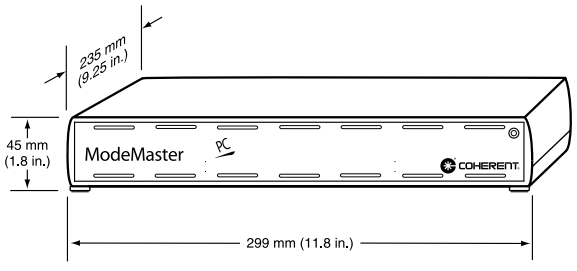
Device Specifications	Model	ModeMaster PC
	Accuracies	
	Waist Diameter (%)	±2
	Waist Location	±8% of input beam Rayleigh Range
	Beam Quality – M^2 (%)	±5
	Divergence (%)	±5
	Beam Translation	±5% of waist diameter +0.1 mm
	Pointing Angle	±5% of divergence +0.04 mrad
	Azimuth Angle Readout	±2°(10 to 200°)
	Knife-Edge Clip Levels	User-adjustable 0% to 100% in 1.5% steps
	ModeMaster PC Control/Interface Module Update Rate	<8 Hz (M^2, divergence, power density, waist diameter, profiles)
	Analog Outputs	Detector signal output, 0 to 13V maximum A/D control signal out, 0 to 5V pulse Trigger (syncs to drum rotation), 0 to 5V pulse
	Digital Outputs	RS-232 interface. Front and back knife-edge widths and pinhole profiles available in digitized form via RS-232
	Power	100 to 240 VAC, 47 to 63 Hz, 40W maximum

Scan Head and Precision Mount



305 mm (12.0 in.) UV VIS NIR
358 mm (14.1 in.) IR High-Divergence
409 mm (16.1 in.) IR Low-Divergence

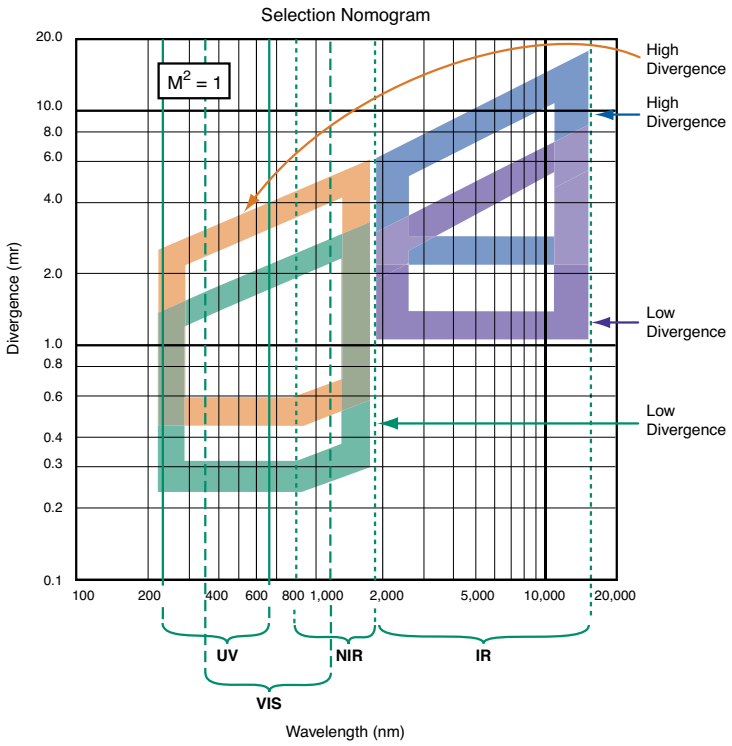
Control/Interface Console



ModeMaster PC

Selecting a ModeMaster PC System Configuration

ModeMaster PC systems are available in eight standard configurations (all include scanning head, 5-axis mount, USB control/interface console, cables, PC software and manual). All configurations provide measurements in four wavelength ranges, with two divergence ranges (high-divergence and low-divergence) within each wavelength range. Use the following steps, along with the Selection Nomogram Chart and Configuration Table (below), to select a ModeMaster PC configuration.



1. Choose between the four spectral ranges: UV (220 to 680 nm), VIS (340 to 1000 nm), NIR (800 to 1800 nm) and IR (1800 to 15,000 nm).
2. Determine the approximate divergence of your laser beam and use the Selection Nomogram (Divergence vs. Wavelength) Chart to select the low-divergence or high-divergence configuration.
3. Confirm that your beam size is <25 mm diameter for the low-divergence configuration or <12 mm for the high-divergence configuration.
4. Use the table below to determine the part number of the ModeMaster PC configuration selected, and to verify all other beam specifications.
5. If more than one ModeMaster PC configuration appears to be needed in order to cover all required beam parameter ranges, optional Scanning Head Modular Components can be ordered to change the configuration of the ModeMaster PC system to cover other ranges (see next page for details).

Standard Configuration

Name	UV Low-Divergence	UV High-Divergence	VIS Low-Divergence	VIS High-Divergence	NIR Low-Divergence	NIR High-Divergence	IR High-Divergence	IR Low-Divergence
Model	MM-1	MM-1S	MM-2	MM-2S	MM-3	MM-3S	MM-4	MM-5
Spectral Range (µm)	0.22 to 0.68		0.34 to 1.00		0.80 to 1.80		1.80 to 15	
Detector Type	Silicon				Germanium		Pyrolelectric	
INPUT BEAM REQUIREMENTS AT TEST WAVELENGTH								
Test Wavelength[1]	351 nm		514 nm		1.06 µm		10.6 µm	
Minimum Power[2]	7.5 mW[3]		2.5 mW[3]		2.5 mW[3]		400 mW	
Maximum Power[2]	10W[3]		25W[3]		2.5W		20W	
Noise	<2% RMS and <5% peak-to-peak							
Min. Divergence (mrad)	0.24	0.46	0.24	0.46	0.25[5]	0.47[5]	2.7	1.3
Max. Divergence (mrad)[4]	1.7	3.2	2.0	3.6	2.7	5.0	14	7.2
Max. Beam Diameter (mm)[6]	25	12	25	12	25	12	12	25
Part Number	33-1843-000	33-2106-000	33-2221-000	33-2239-000	33-2387-000	33-2395-000	33-2429-000	33-2437-000

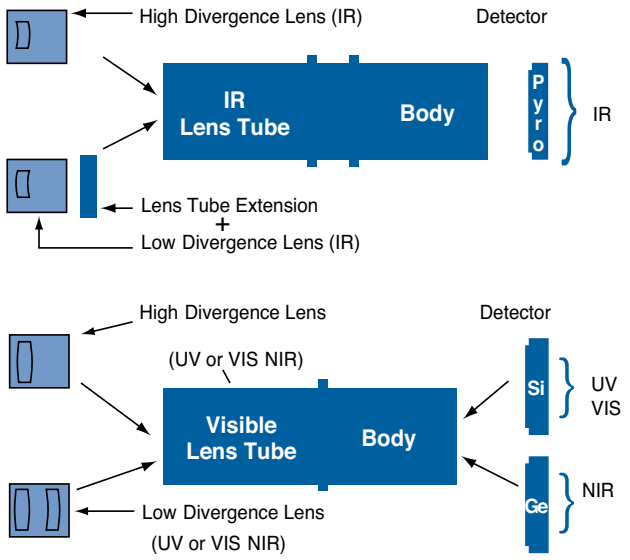
[1] Wavelength-dependent quanlities are input power levels, and minimum and maximum divergence (see Notes 2, 5, 6).
[2] Power levels are proportional to the inverse of the spectral response of the detector. The silicon detector peaks at 900 nm and is at half-peak sensitivity at 510 nm and 1050 nm. The germanium detector peaks at 1500 nm and is at half-peak sensitivity at 1100 nm and 1650 nm. The pyroelectric detector has a flat spectral response.
[3] These limits can be reduced by a factor of 10 (higher sensitivity) by user-removal of the light-restricting aperture in front of the detector.
[4] The maximum divergence limit is fixed by the inability to accurately locate the internal waist when the internal beam diameter growth (over the span of the drum) is too slight. Limits shown are for M^2 = 1 and test wavelength; limits scale as the square root of M^2 (test wavelength).
[5] Minimum divergence in this wavelength range scales as the square root of M^2 (test wavelength).
[6] Diameters are approximate; divergence takes precedence in choosing options. Refer to nomogram.

ModeMaster PC

Complete Geometric Beam Characterization Along the Laser Beam Path

Components for Other Wavelength and Divergence Ranges
The body design of the ModeMaster PC scanning head has modular lens and detector sets that allow quick changes to other wavelength or divergence ranges to meet your measurement needs.

The IR body can only be used with the IR (pyroelectric - pyro) detector and either the low-divergence or high-divergence IR heads. The UV-VIS-NIR body, however, can be used in any of the UV, VIS or NIR spectral regions with the appropriate detector (silicon-Si for the UV and VIS; germanium-Ge for the NIR) and low- or high-divergence lenses. The UV lens can be used with the silicon detector and the VIS-NIR lens can be used with either the silicon or germanium detector.



Part Number	Description	Spectral Region(s)	Scan Head Body
33-2072-000	Silicon Detector (0.22 to 1.0 µm)	UV, VIS	UV-VIS-NIR
33-2080-000	Germanium Detector (0.8 to 1.8 µm)	NIR	UV-VIS-NIR
33-2098-000	Pyroelectric Detector (1.8 to 20 µm)	IR	IR
33-2114-000	High-Divergence Lens Kit	UV	UV-VIS-NIR
33-2130-000	Low-Divergence Lens Kit	UV	UV-VIS-NIR
33-2122-000	High-Divergence Lens Kit	VIS, NIR	UV-VIS-NIR
33-2148-000	Low-Divergence Lens Kit	VIS, NIR	UV-VIS-NIR
33-2155-000	High-Divergence Lens Kit	IR	IR
33-2166-000	Low-Divergence Lens Kit	IR	IR

ModeMaster PC M^2 Beam Propagation Analyzer (standard system configuration)

Part Number	Description	Spectral Range
33-1843-000	ModeMaster PC System[1]	UV, Low-Divergence
33-2106-000	ModeMaster PC System[1]	UV, High-Divergence
33-2221-000	ModeMaster PC System[1]	VIS, Low-Divergence
33-2239-000	ModeMaster PC System[1]	VIS, High-Divergence
33-2387-000	ModeMaster PC System[1]	NIR, Low-Divergence
33-2395-000	ModeMaster PC System[1]	NIR, High-Divergence
33-2437-000	ModeMaster PC System[1]	IR, Low-Divergence
33-2429-000	ModeMaster PC System[1]	IR, High-Divergence
33-1710-000	ModeMaster PC Control/Interface Console and Software	–

[1] All ModeMaster systems include scan head, mount, control/interface console and software.

WaveMaster

Laser Wavelength Meter

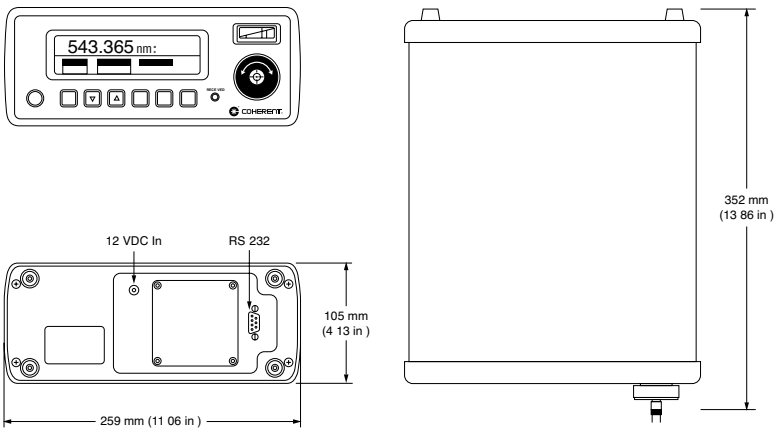
Features

- 380 nm to 1095 nm wavelength range
- RS-232 interface
- Internal self-calibration
- Fiber input with sampling probe

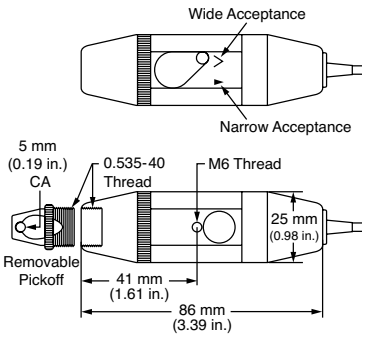
Device Specifications

Model	WaveMaster
Wavelength Coverage (nm)	380 to 1095
Accuracy (nm)	0.005
Resolution (nm)	0.001
Minimum Pulse Rep. Rate	Single shot
Maximum Pulse Rep. Rate	CW
Maximum Signal Bandwidth (nm)	2 at 400 3 at 600 5 at 1000
Minimum Signal	20 µW CW at 632 nm 2 mJ pulsed at 1064 nm
Maximum Signal	100 mW CW at 632 nm 100 mJ pulsed at 1064 nm
Display Update (Hz)	3
Size (W x H x D) (mm)	259 x 105 x 352
Storage	
Storage Condition	-10°C to 50°C (14°F to 122°F)
Relative Humidity	Non-condensing and <80%
Shock (g)	>4
Use Conditions	-10°C to 40°C (14°F to 104°F)
Relative Humidity	Non-condensing and <80%
Shock (g)	<4
Power Supply (included)	Universal 90 to 250 VAC; 40 to 72 Hz in; 12 VDC out
Part Number	33-2650-000

WaveMaster



Sampling Probe



WaveMaster

Laser Wavelength Meter

The WaveMaster measures the wavelength of both CW and pulsed lasers of any repetition rate. The wavelength can be displayed in GHz, wave numbers, or nanometers, with vacuum and air readings available. The WaveMaster will read the peak wavelength of sources as wide as 2 nm from 380 nm to 1095 nm. Bandwidths wider than 2 nm can be accommodated at the longer wavelengths.

The WaveMaster is easy to use. Just turn on the readout and get the beam within 10 degrees of normal incidence to the sampling probe. The probe has a 2-meter fiberoptic cable and takes up a minimum of beam path space. Most intensity variances are automatically accommodated, but for the strongest and weakest signals a front panel attenuator adjustment and intensity readout quickly produce accurate readings. No special triggering modes or setups are required for pulse capture.

User-Friendly
The WaveMaster is easy to read with front panel adjustments of contrast and back-lighting for the extra-large display. Parameters that have been set-up are clearly displayed, in addition to signal intensity and pulse-retrieved indicators. Configuration settings are maintained in memory and retrieved on start-up for convenience. Communication with the WaveMaster is also easy with a built-in RS-232 port.

Sophisticated algorithms that monitor the WaveMaster's response maintain calibration. Periodically, and upon indication from the algorithms, the WaveMaster is referenced to the fundamental lines of an internal NE source.

Pulse or CW Operation
The operational mode can be changed from CW, to CW with averaging, to pulse. In CW mode the display is updated at 3 Hz. In CW with averaging, the display is updated at 3 Hz with an average of the last 10 readings taken at 3 Hz. For pulse mode, when a valid pulse is received the display will show the wavelength reading of the pulse for 15 seconds, or until another valid pulse is received.

No Warm-Up Time
When the WaveMaster is first powered on, it will perform a self-test cycle and then enter the auto-calibration mode. After 10 seconds, the AUTOCAL message is cleared from the display and the WaveMaster is ready to make measurements.

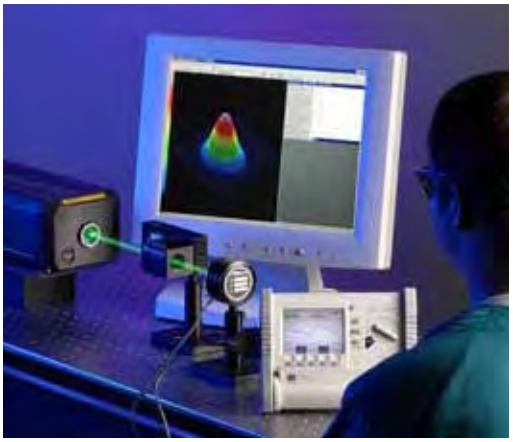
Accurate
With its self-monitoring algorithms and an internal spectral line source, the WaveMaster auto-calibrates the internal spectrometer to maintain accuracy.

Easy Set-Up
Feedback from the WaveMaster is straightforward. Once the signal is applied to the probe, the unit begins sampling to simplify set-up. In CW mode, the WaveMaster will auto-range to adjust the sensor integration time to match the incoming signal. This allows the quickest set-up and greatest versatility.

Selected Display Units
The wavelength readings can be displayed in nanometers in "air" at standard temperature and pressure (STP), or shown as a calculated conversion from STP to nanometers in a "vacuum", or displayed as wave numbers (cm^{-1}), or as frequency (GHz).

Calibration and Service

Certification



Calibrate Equipment to Maximize Longevity
Laser power and energy meters from Coherent are precision instruments, capable of delivering very accurate measurements during many years of useful service. To maintain this high level of performance and to ensure compliance with your ISO certification, it is important to have your measurement system serviced and recertified once a year. Extended use of laser power and energy meters, as well as local environmental factors, can have an adverse effect on accuracy and also result in wear and damage to parts critical to optimum performance.

Recertify Once a Year
To optimize performance and longevity, and to remain compliant with ISO requirements, Coherent recommends that power/energy meters and sensors be recertified at least once a year.

We Provide Certification
Our investment in service and calibration facilities and personnel is ongoing, and we strive to maintain our unique technological edge. Our Quality Management System is registered to ISO 9001:2000, our products are NIST-traceable, and our calibration labs meet the requirements of ANSI Z540.

Our Calibration Lab has a full spectrum of light sources from 193 nm to 10,600 nm with powers ranging from nanowatts to kilowatts. By duplicating the actual environment of the user, we can calibrate, verify and certify all laser power/energy meters.

Obtaining Warranty Service
In order to arrange for warranty service or annual recalibration, contact your closest Coherent service center to obtain a Return Material Authorization (RMA) number (see next page).

Initial Evaluation
When you return equipment to Coherent for calibration, each device is given a thorough initial evaluation to determine if it can be calibrated adequately in its "As Received" condition.

Repair and Calibration
At times we may find it necessary to repair the device before the final calibration can take place. If any problems are identified, or if repairs will result in additional charges, you will be contacted by a Customer Service representative. Only then will we calibrate and recertify your equipment in our labs.

Reporting Results
Returned equipment is accompanied by a Calibration Certificate including Before and After results for sensors, and a data report.

Calibration and Service

Warranty

Limited Warranty
Coherent, Inc., warrants to the original purchaser that its laser power and energy meters and sensors are free from defects in materials and workmanship and comply with all specifications, active at the time of purchase, for a period of twelve (12) months. Coherent, Inc., will, at its option, repair or replace any product or component found to be defective during the warranty period. This warranty applies only to the original purchaser and is not transferable.

Extended Warranty
Coherent, Inc., offers original purchasers of laser power and energy meters and sensors an extended twelve month warranty program, which includes all parts and labor. In order to qualify for this warranty, a Customer must return the Product to the Company for recalibration and recertification. The Company will recertify the Product, provide software upgrades, and perform any needed repairs, and recalibrate the Product, for a fixed service fee. If the Product fails and is returned to the Company within one year following the date of recalibration and recertification service, the Company will, at its option, repair or replace the Product or any component found to be defective.

Contact Coherent or visit www.Coherent.com/LMC for additional details and warranty limitations.

Obtaining Warranty Service
In order to arrange for warranty service or annual recalibration, first contact your closest Coherent service center to obtain a Return Material Authorization (RMA) number.

USA
Phone: 800 343 4912
Fax: 503 454 5727
E-mail: LMC.sales@coherent.com

Asia
Phone: 813 5635 8680
Fax: 813 5635 8681
E-mail: LMC.sales@coherent.com

Europe
Phone: 49 6071 9680
Fax: 49 6071 968499
E-mail: LMC.sales@coherent.com

Detailed instructions for preparing and shipping your instrument can be found below.

Instructions for Returning Equipment for Service and Calibration

To prepare your instrument, meter or sensor for return to Coherent, attach a tag to the unit that includes the name and address of the owner, the contact individual, the serial number, and the RMA number you received from Customer Service.

Wrap the product with polyethylene sheeting or equivalent material. If the original packing material and carton are not available, obtain a corrugated cardboard shipping carton with inside dimensions that are at least 6 in. (15 cm) taller, wider, and deeper than the product. The shipping carton must be constructed of cardboard with a minimum 375 lbs. (170 kg) test strength. Cushion the instrument unit in the shipping carton, using 3 in. (7.5 cm) of packing material or urethane foam on all sides, top, bottom, and between the carton and the instrument or sensor. Seal the shipping carton with shipping tape or an industrial stapler.

Shipping addresses for our repair and calibration facilities are given below:

USA
Coherent Laser Measurement
and Control Service Center
Attn: (your RMA number)
27650 SW 95th Avenue
Wilsonville, OR 97070
USA

Europe
Coherent (Deutschland) GmbH
Dieselstr. 5b
D-64807 Dieburg
Germany

Asia
Coherent Japan
Toyo MK Building
7-2-14 Toyo
Koto-Ku, Tokyo
135-0016 Japan

Measurement Products for Use with Coherent Lasers

Matrix of Recommendations*

CO_2 (Diamond) Lasers	**Laser**	**Wavelength (µm)**	**Power Meter**	**Power Sensor**
	C-30	10.6	FieldMaxII-TO	PM30
	C-40, C-55, C-70	10.6	FieldMaxII-TO	PM150
	G-100, G-150	10.2 to 10.7	FieldMaxII-TO	PM150
	G-100i	9.4 ±0.3	FieldMaxII-TO	PM150
	K-250, K-225i, K-300	10.4 to 10.8	FieldMaxII-TO	PM300F-19
	E-400, K-500	10.2 to 10.8	FieldMaxII-TO	PM1K
Diode Lasers	**Laser**	**Wavelength (nm)**	**Power Meter**	**Power Sensor**
	CUBE	375 to 785	FieldMaxII-TO	PS10
	Radius	375 to 635	FieldMaxII-TO	PS10
	All Laser Diode Modules		FieldMaxII-TO	PS10
	FAP	780 to 840	LabMax-TOP	LM-150FS + SMA adapter
	HighLight FAP	785 to 820	LabMax-TOP	LM-150FS + SMA adapter
	Quattro FAP	790 to 980	LabMax-TOP	LM-150FS + SMA adapter
	HighLight 4000L	805 to 940	FieldMaxII-TO	PM5K-100
	HighLight 1000F	975	FieldMaxII-TO	PM1K
Diode-Pumped Solid-State Lasers (CW)	**Laser**	**Wavelength (nm)**	**Power Meter**	**Power Sensor**
	Azure	266	FieldMaxII-TO	PM10X or PS10[1]
	Compass 115M, 215M, 315M	532	FieldMaxII-TO	PS10
	Compass 561	561	FieldMaxII-TO	PS10
	Genesis CX STM[2]	355, 460, 480, 488, 532, 577	FieldMaxII-TO	PM10
	Genesis MX STM[2]	460, 480, 488, 532, 561, 577	FieldMaxII-TO	PM10
	Genesis Taipan	460, 480, 488, 532, 561, 577	FieldMaxII-TO	PM10
	MBD 200	455 to 1070	FieldMaxII-TO	PS10
	MBD 266	266	FieldMaxII-TO	PM10X or PS10[1]
	Paladin 355	355	FieldMaxII-TO	PM10X
	Sapphire LP Family	458, 460, 488, 514, 532, 561, 568	FieldMaxII-TO	PS10
	Sapphire 488 HP	488	FieldMaxII-TO	PM10
	Verdi G2, G5, G7, G8	532	FieldMaxII-TO	PM10
	Verdi V2, V6, V8	532	FieldMaxII-TO	PM10
	Verdi V10, V12, V18	532	FieldMaxII-TO	PM30
	Verdi IR	1064	FieldMaxII-TO	PM30

Diode-Pumped Solid-State Lasers (Pulsed)	**Laser**	**Wavelength (nm)**	**Power Meter**	**Power Sensor**	**Energy Meter**	**Energy Sensor**
	AVIA (<10W)	266, 355	FieldMaxII-TO	PM10X	-	-
	AVIA (10W to 30W)	355, 532	FieldMaxII-TO	PM30X	-	-
	AVIA (>30W)	532	FieldMaxII-TO	PM150	-	-
	Indigo-DUV	193	FieldMaxII-TO	PS10	LabMax-TOP	J-10MT-10KHZ
	Indigo-S	193 to 900	FieldMaxII-TO	PS10	LabMax-TOP	J-10MT-10KHZ
	MATRIX 532, 1064	532, 1064	FieldMaxII-TO	PM10	-	-
	MATRIX 355	355	FieldMaxII-TO	PM10X	-	-
	PRISMA (<10W)	532, 1064	FieldMaxII-TO	PM10	-	-
	PRISMA (>10W)	532, 1064	FieldMaxII-TO	PM30	-	-
	Talisker	355, 532, 1064	FieldMaxII-TO	PM30	-	-

* Other Coherent measurement product configurations may be compatible with these lasers. Coherent Family Plan pricing may apply (see page 103). Contact factory for more details.

[1] For these lasers, the PS10 can be selected for users who are looking for either higher resolution or low power measurements.

[2] Available in OEM or end user versions.

Measurement Products for Use with Coherent Lasers

Matrix of Recommendations*

Ion Lasers	**Laser**		**Wavelength (nm)**		**Power Meter**	**Power Sensor**
	Innova (<1W)		200 to 1100		FieldMaxII-TO	PS10
	Innova (>1W)		200 to 1100		FieldMaxII-TO	PM10
Q-Switched Lasers	**Laser**	**Wavelength (nm)**	**Power Meter**	**Power Sensor**	**Energy Meter**	**Energy Sensor**
	Evolution (<30W)	527	FieldMaxII-TOP	PM30	LabMax-TOP	J-25MT-10KHZ plus medium heat sink
	Evolution (>30W)	527	FieldMaxII-TOP	PM150		
Ultrafast Oscillators, Amplifiers and Accessories	**Laser**		**Power Meter**	**Power Sensor**	**Energy Meter**	**Energy Sensor**
	Pump Lasers					
	Verdi V2, V5, V6, V8		FieldMaxII-TO	PM10	-	-
	Verdi V10, V12, V18		FieldMaxII-TO	PM30	-	-
	Evolution-15/30		FieldMaxII-TO	PM30	LabMax-TOP	J-25MT-10KHZ[1]
	Evolution-HE		FieldMaxII-TO	PM150	-	-
	Oscillators					
	Micra		FieldMaxII-TO	PM10 or PS10[2]	-	-
	Mira-900		FieldMaxII-TO	PM10	-	-
	Mira-HP		FieldMaxII-TO	PM10	-	-
	Chameleon		FieldMaxII-TO	PM10	-	-
	Vitesse		FieldMaxII-TO	PM10 or PS10[2]	-	-
	Mantis		FieldMaxII-TO	PM10 or PS10[2]	-	-
	Oscillator Accessories					
	Mira-OPO		FieldMaxII-TO	PS10	-	-
	Chameleon Compact OPO		FieldMaxII-TO	PS10	-	-
	Amplifiers[3]					
	Legend Elite (F, P, USP, USX)		FieldMaxII-TO	PM10	LabMax-TOP	J-25MT-10KHZ
	Legend Elite Duo (F, P, USP, USX)		FieldMaxII-TO	PM30	LabMax-TOP	J-50MT-10KHZ
	Legend Cryo		FieldMaxII-TO	PM10	LabMax-TOP	J-25MT-10KHZ
	Libra		FieldMaxII-TO	PM30	LabMax-TOP	J-25MT-10KHZ[1]
	RegA 9000/9050		FieldMaxII-TO	PS10		
	Hidra		FieldMaxII-TO	PM10V1	FieldMaxII-TOP	J-50MT-10KHZ
	Amplifier Accessories					
	OPerA Solo		FieldMaxII-TO	PM10 or PS10[2]	LabMax-TOP	J-10MT-10KHZ (<1 mJ pump) J-10MB-HE (>1 mJ pump)
	TOPAS		FieldMaxII-TO	PM10 or PS10[2]	LabMax-TOP	J-10MT-10KHZ (<1 mJ pump) J-10MB-HE (>1 mJ pump)

* Other Coherent measurement product configurations may be compatible with these lasers. Coherent Family Plan pricing may apply (see page 103). Contact factory for more details.

[1] With medium heat sink.

[2] The PS10 is recommended when making higher resolution or low power measurements.

[3] See above for sensors to measure pump lasers.

Measurement Products for Use with Coherent Lasers

Matrix of Recommendations*

Excimer Lasers	Laser	Wavelength (nm)	Power Meter	Power Sensor	Energy Meter	Energy Sensor
	BraggStar	193, 248	FieldMaxII-TO	PM10X	LabMax-TOP	J-25MT-10KHZ
	COMPexPro F2	157	FieldMaxII-TO	PM10X	FieldMaxII-TOP	J-25MUV-193
	COMPexPro 50, 102, 110, 201, 205	193	FieldMaxII-TO	PM150-50XC	FieldMaxII-TOP	J-50MUV-193
	COMPexPro 50, 102, 110, 201, 205	248	FieldMaxII-TO	PM150X	FieldMaxII-TOP	J-50MUV-248 plus large heat sink
	COMPexPro 102, 110, 201, 205	308, 351	FieldMaxII-TO	PM150X	FieldMaxII-TOP	J-50MB-YAG
	ExciStar XS 200	157, 193	FieldMaxII-TO	PM10X	FieldMaxII-TOP	J-25MUV-193
	ExciStar XS 200	248, 351	FieldMaxII-TO	PM10X	FieldMaxII-TOP	J-25MUV-248
	ExciStar XS 500	157, 193, 248, 351	FieldMaxII-TO	PM10X	LabMax-TOP	J-25MT-10KHZ
	IndyStar	193, 248	FieldMaxII-TO	PM30X	LabMax-TOP	J-25MT-10KHZ plus small heat sink
	LPFpro 205, 220	157	FieldMaxII-TO	PM150-50XC	FieldMaxII-TOP	J-50MUV-193
	LPXpro 210, 220, 305	193, 248, 308, 351	FieldMaxII-TO	PM150X, PM150-50XC	-	-
	Xantos XS	157, 193, 248, 351	FieldMaxII-TO	PM10X	LabMax-TOP	J-25MT-10KHZ
	LAMBDA SX-Series	248, 308	FieldMaxII-TO	PM300F-50X PM1KX1	-	-

* Other Coherent measurement product configurations may be compatible with these lasers. Coherent Family Plan pricing may apply (see page 103). Contact factory for more details.

Model Name Index

Model Name	Page Number
1000:1 Attenuator	50
1.035-40M Adapter Ring	51
Barrell Set	83
BCUBE	83
BeamFinder	37, 70
BeamMaster	72, 87
BIP-12F (1:1)	84
BIP-12F (2:1)	84
BIP-5000SPL	84
BIP-5000Z	84
C-VARM	83
EPM2000	53
FC/PC Type Connector	51
FieldMate	15
FieldMaxII-P	14
FieldMaxII-TO	14
FieldMaxII-TOP	14, 53
Germanium Detector	93
High-Divergence Lens Kit IR	93
High-Divergence Lens Kit UV	93
High-Divergence Lens Kit VIS,NIR	93
IR High-Divergence	92
IR Low-Divergence	92
J100 Energy Sensor	67
J-10MB-HE	58
J-10MB-LE	58
J-10MT-10KHZ	59
J-10SI-LE	62
J-10SI-HE	62
J-10GE	62
J-25MB-HE	58
J-25MB-IR	60
J-25MT-10KHZ	59
J-25MUV-193 w/o Diffuser	61
J-25MUV-248 w/o Diffuser	61
J-50MB-HE	58
J-50MB-IR	60
J-50MB-LE	58
J-50MB-YAG	60
J-50MT-10KHZ	59
J-50MUV-193 w/ Diffuser	61
J-50MUV-193 w/o Diffuser	61
J-50MUV-248 w/ Diffuser	61
J-50MUV-248 w/o Diffuser	61
J-Power Energy Sensor Adapter	65
LabMax-TO	12
LabMax-TOP	12, 53
LabMax-TOP w/GPIB	12
Large Heat Sink	64
LaserCam-HR-InGaAs	75
LaserCam-HR-UV	74
LaserCam-HR	74
LaserCheck	8
LM-10	26, 31
LM-100	35
LM-1000	27
LM-150 FS	36
LM-150 LS	36
LM-2 IR	38
LM-2 UV	38
LM-2 VIS	38
LM-20	36
LM-200	35
LM-2500	37
LM-3	26, 34
LM-45	26, 34
LM-5000	37
Low-Divergence Lens Kit IR	93
Low-Divergence Lens Kit UV	93
Low-Divergence Lens Kit VIS,NIR	93
Medium Heat Sink	64
ModeMaster PC	88
NIR High-Divergence	92
NIR Low-Divergence	92
OP-2 IR	38
OP-2 UV	38
OP-2 VIS	38
PM10	40
PM100-19C	41
PM10-19A	69
PM10-19B	69
PM10-19C	29
PM10V1	46
PM10X	47

Model Name Index

Model Name	Page Number
PM150	41
PM150-19A	69
PM150-19B	69
PM150-19C	42
PM150-50	41
PM150-50A	69
PM150-50B	70
PM150-50C	29, 42
PM150-50XB	70
PM150-50XC	48
PM150X	48
PM1K	44
PM1K-100	45
PM1K-36B	70
PM1K-36C	27
PM1KX	49
PM2	40
PM200F-19	43
PM200F-50	43
PM200F-50X	49
PM2X	47
PM3	23, 39
PM30	40
PM300	42
PM300F-19	43
PM300F-50	43
PM300F-50X	49
PM30V1	46
PM30X	47
PM3K	44
PM3K-100	45
PM3Q	39
PM5K	44
PM5K-100	45
PM5K-200	45
PS10	23
PS10Q	23, 39
PS19	23, 39
PS19Q	39
PS-FC-Type Connector	51
PS-SMA-Type Connector	51
P-TM7 1/2"	61

Model Name	Page Number
Pyroelectric Detector	79
Pyroelectric Test Slide Black Coating	65
Pyroelectric Test Slide Diffuse Metallic Coating	65
Pyroelectric Test Slide MB Coating	65
Pyroelectric Test Slide MUV Coating	65
Silicon Detector	93
Small Heat Sink	64
SMA-Type Connector	51
Thermal SmartSensor Adapter	50
UV BCUBE	83
UV High-Divergence	92
UV Low-Divergence	92
UV-C VARM	83
VARM	83
VIS High-Divergence	92
VIS Low-Divergence	92
WaveMaster	72, 94
UV/VIS	24

Doing Business with Coherent

Ordering
We are pleased to accept orders online at www.Coherent.com, or by phone, fax, e-mail or mail. When confirming an order that has been placed, please indicate "confirming" on the order.

Pricing
Prices are FOB Portland, OR, and do not include freight, duty or any applicable taxes.

Please consult your local Sales Office or Distributor for export prices.

Coherent Family Plan
Customers who have purchased a Coherent laser valued at greater than US $5.0K within the past 12 months are entitled to a 20% discount on Coherent laser measurement products.

Terms of Payment
Acceptable terms of payment for domestic orders include cash with order, major credit card, C.O.D. or Net 30 with prior approval of credit.

Export terms are strictly letter of credit, cash in advance or major credit card.

Shipping
Shipment means are at the discretion of Coherent, but we will attempt to meet your special requests. We do not take responsibility for any delays or damage caused by the shipper.

Returns
Returns are accepted only after a return authorization number has been obtained from Coherent, and credit will be allowed for items returned under authorization in good condition.

Order Cancellation
Cancellation of orders will incur a termination charge of not less than 10% of the order value, and Coherent reserves the right to charge for all costs incurred in support of any cancelled order.

Warranty
Goods are warranted to be free from defects and to work in the manner specified for a period of 12 months from date of shipment. See page 97 for further warranty details.

Specifications
Specifications are current at the time of publication, but Coherent reserves the right to change these specifications at any time. Refer to www.Coherent.com for the most current product specifications.

Terms and Conditions of Sale
Terms and Conditions of Sale are specific to each country in which Coherent operates. They are supplied with all quotations and invoices and can be sent by fax or mail on request. Nothing in the foregoing statements modifies the Terms and Conditions in effect for each country of operation.

RoHS Compliance
The majority of products in this catalog are RoHS compliant. For more information on specific products, please contact a Coherent Sales Office or Representative.

How to Contact Us

Contact Us by Phone

Coherent, Inc. (800) 343-4912 or (408) 764-4042
Benelux: +31 (30) 280 6060
China: +86 (10) 6280 0209
France: +33 (0)1 6985 5145
Germany: +49 (6071) 968333
Italy: +39 (02) 34 530 214
Japan: +81 (3) 5635 8680
Korea: +82 (2) 460 7900
United Kingdom: +44 (0) 1353 658833

Contact Us by Email

Laser Products: tech.sales@coherent.com
Laser Measurement: lmc.sales@coherent.com
Service: product.support@coherent.com

All Coherent product names are trademarks of Coherent, Inc.
*All products indicated by an asterisk are registered trademarks of their respective companies.

COHERENT

Visit the Coherent Website

for more information about how Coherent can enable your laser measurement application.

www.Coherent.com/LMC

Use the Product and Application Finders below to quickly get more helpful details.

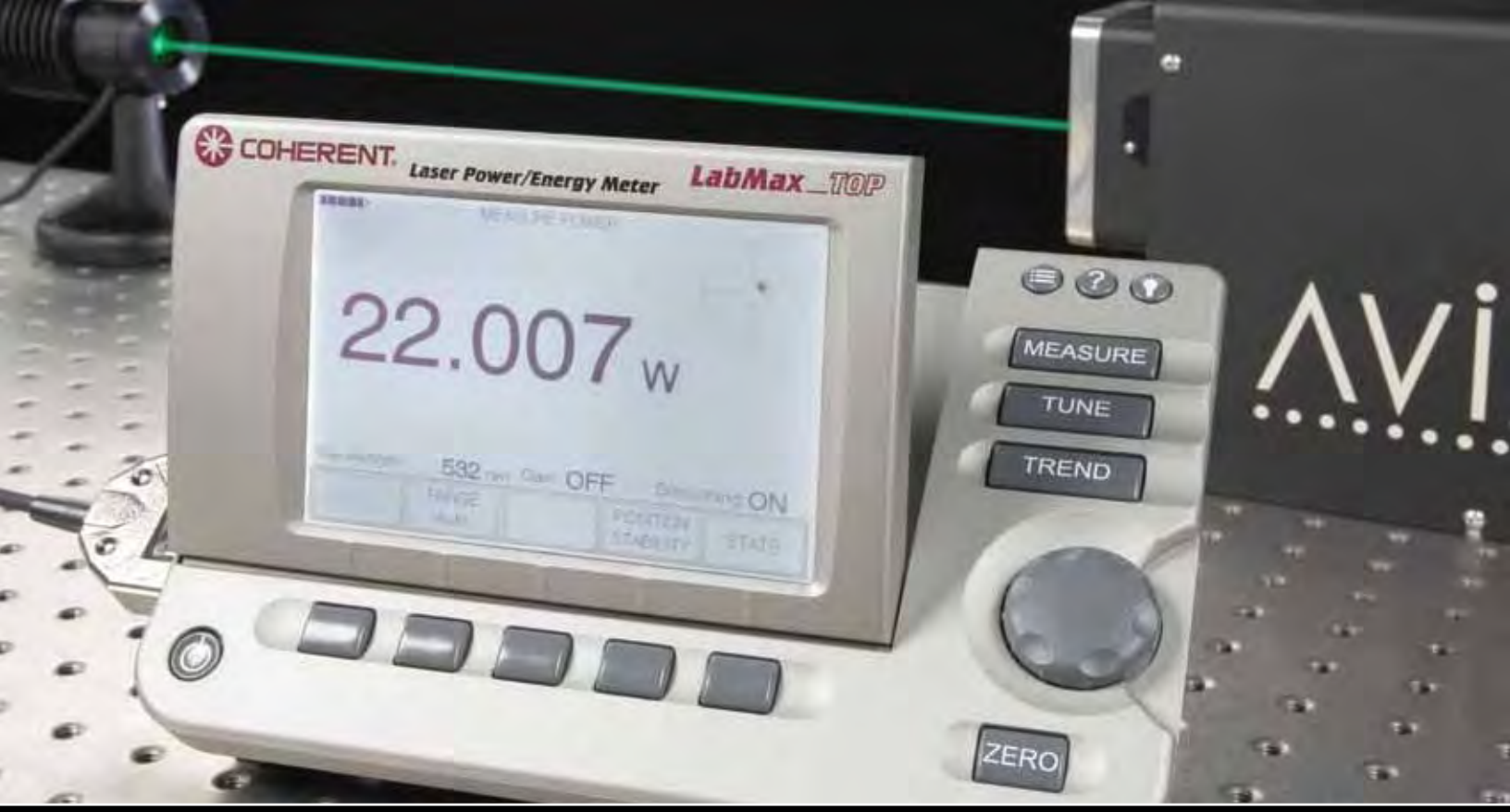
Comprehensive Meter and Sensor Finder

Applications Software and Drivers

Frequently Asked Questions

Enhanced Application Finder

Brochures, Tech Notes, Technical Illustrations, Videos, Data Sheets



COHERENT

Coherent, Inc., Corporate Headquarters
5100 Patrick Henry Drive
Santa Clara, CA 95054

United States
Coherent, Inc., Portland
27650 SW 95th Avenue
Wilsonville, OR 97070
United States
Toll Free: 1-800-343-4912
Tel: (408) 764-4042
Fax: (503) 454-5727
www.Coherent.com

China
Coherent, Inc., Beijing
Room 215 Yin Gu Building
No. 9 Beisihuan Xi Road
Haidian District
Beijing, 100080, China
Tel: +86-10-6280-0209
Fax: +86-10-6280-0129
www.Coherent.com.cn

France
Coherent France
Domaine Technologique de Saclay
Bâtiment Azur
4, Rue René Razel
91892 Orsay Cedex
France
Tel: +33-1-69-85-51-45
Fax: +33-1-60-19-40-00
www.Coherent.fr

Germany
Coherent GmbH
Dieselstraße 5b
D-64807 Dieburg
Germany
Tel: +49-6071-968-333
Fax: +49-6071-968-499
www.Coherent.de

Italy
Coherent Italia
Via Borgese, 14
Milano, 20154
Italy
Tel: +39-02-34-530-214
Fax: +39-02-34-934-165
www.Coherent.it

Japan
Coherent Japan, Inc.
Toyo MK Building
7-2-14 Toyo
Koto-ku, Tokyo 135-0016
Japan
Tel: +81 3-5635-8680
Fax: +81 3-5635-8701
www.Coherent.co.jp

Korea
Coherent Korea
No. 101, Eagle Town
278-20, 3 dong
Seongsu 2 ga
Seongdong-gu, Seoul
133-832, South Korea
Tel: +82 2 460 7900
www.Coherent.com

Netherlands
Coherent B.V.
Smart Business Park
Kanaalweg 18A
3526 KL Utrecht
Netherlands
Tel: +31-30-280-6060
Fax: +31-30-280-6077
www.Coherent.nl

United Kingdom
Coherent UK Ltd.
St Thomas' Place
Cambridgeshire Business Park
Ely
CB7 4EX
United Kingdom
Tel: +44-1353-658-833
Fax: +44-1353-659-110
www.Coherent.com

Printed in the U.S.A. MC-010-09-xM1110Rev.C
Copyright © 2010 Coherent, Inc.